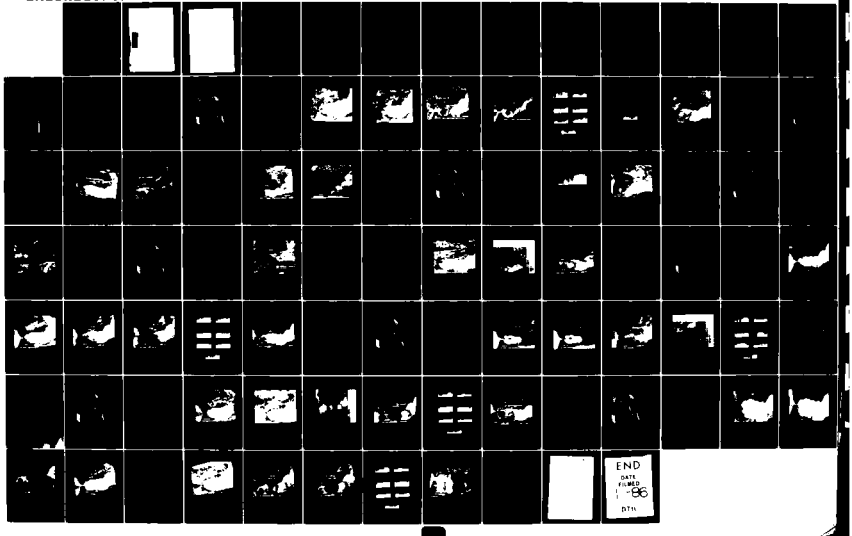
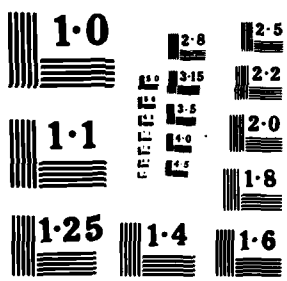
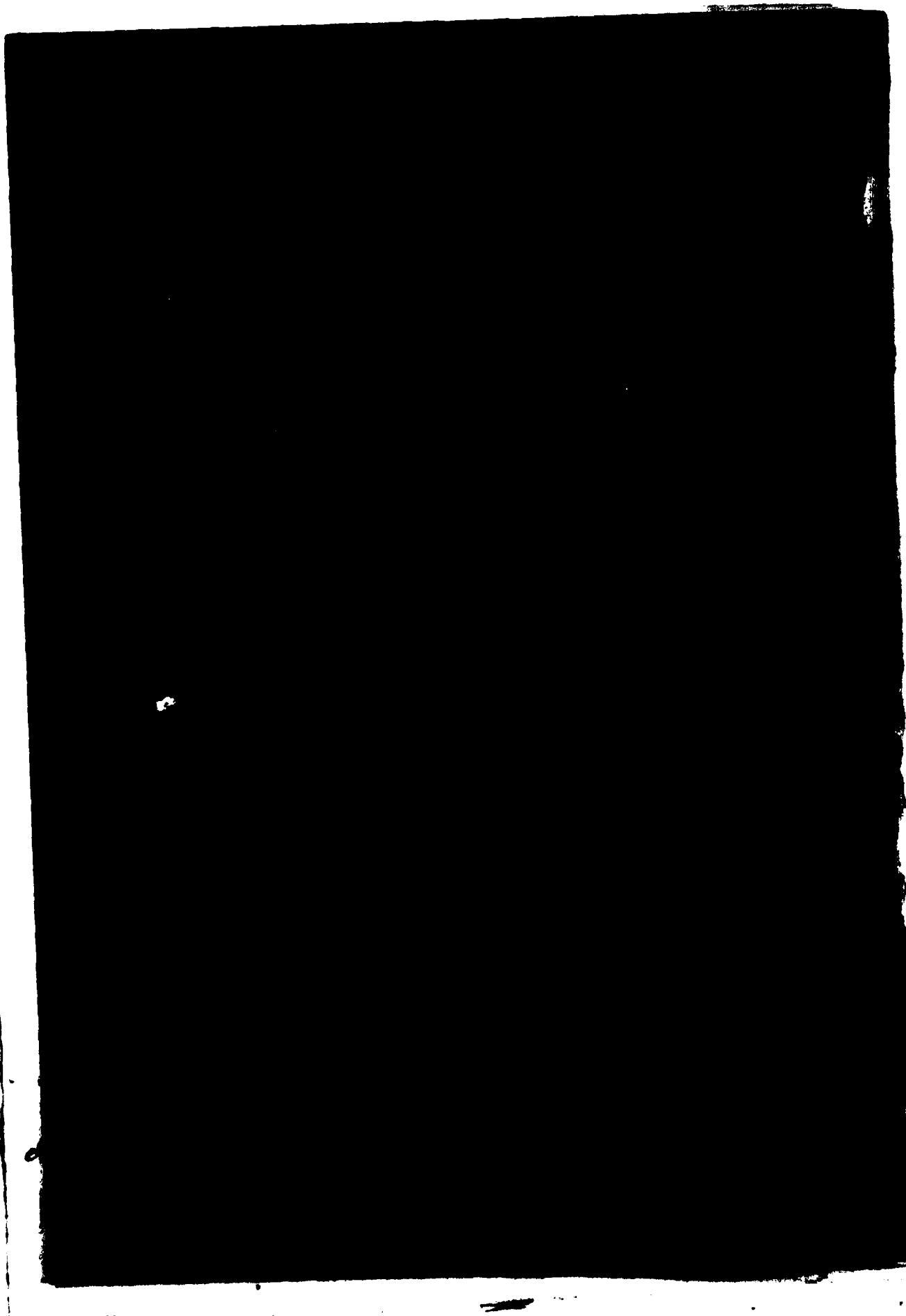
AD-A161 898 AN ATLAS OF ORIGINAL AND MERCATOR-TRANSFORMED SATELLITE-DATA IMAGES OF TH..(U) SACLANT ASW RESEARCH CENTRE LA SPEZIA (ITALY) E MACINI 01 AUG 85 1/1

UNCLASSIFIED SACLANTCEN-SR-80 F/G 14/5 NL




1·0
1·1
1·25
1·4
1·6
2·8
3·15
3·5
2·5
2·2
2·0
1·8



E R R A T U M - SR-89

INSTRUCTIONS

1. P.3, paragraph 5 - Delete the last sentence beginning "The organization of those figures..."

2. Attach this sheet to the inside cover.

SACLANTCEN
Scientific and Technical
Information Department

2 October 1985

SACLANTCEN REPORT SR-89

NORTH ATLANTIC TREATY ORGANIZATION

SACLANT ASW Research Centre
Viale San Bartolomeo 400,
I-19026 San Bartolomeo (SP), Italy.

tel: national 0187 540111
international + 39 187 540111

telex: 271148 SACENT I

AN ATLAS OF ORIGINAL AND MERCATOR-TRANSFORMED SATELLITE-DATA IMAGES OF THE ALBORAN SEA, AUGUST-OCTOBER 1983

by

Elvio Nacini

1 August 1985

This report has been prepared as part of Project 23.

APPROVED FOR DISTRIBUTION

Ralph R. Goodman

RALPH R. GOODMAN
Director

TABLE OF CONTENTS

List of Figures

AN ATLAS OF ORIGINAL AND MERCATOR-TRANSFORMED SATELLITE-DATA IMAGES OF THE ALBORAN SEA, AUGUST-OCTOBER 1983

by

Elvio Nacini

ABSTRACT

This paper presents a collection of satellite (NOAA7) images of the Alboran Sea in HRPT and APT format in the visible, near-infrared, and thermal infrared fields. Some of them have been transformed to Mercator projection in order to show how the use of such images can aid in the preparation and conduct of oceanographic and other operations.

INTRODUCTION

Since 1980 SACLANTCEN has developed the capability to receive satellite data images in APT format at its laboratory and aboard its research ship, MARIA PAOLINA G. These images, supplemented by more detailed HRPT-format images received from the University of Dundee, are used in the analysis of oceanographic studies.

However, the images received are distorted by the earth's curvature, thereby making it difficult to relate them directly to oceanographic and navigation charts of the areas being studied. To overcome this problem SACLANTCEN has developed a program that converts the original images to a format based on a Mercator projection.

The purpose of the present atlas is to present some examples of the satellite data images received at SACLANTCEN and at the University of Dundee and of some of the subsequent transformations to Mercator projection so as to demonstrate the Centre's present capabilities in this subject and to show how the work can be used in oceanographic analysis.

The area chosen for the examples is the Alboran Sea (Figs. 1 and 2), which lies at the western end of the Mediterranean and where SACLANTCEN has recently completed several studies of the water mass circulation [1,2]. The examples published here are taken from an atlas of 82 full-sized original images that has been lodged in the library of the SACLANTCEN Scientific and Technical Information Department.

The following text describes how the original images were collected, how some of them have been transformed to Mercator projection, and how they may be used in various types of oceanographic analysis. The data used are listed in Table 1. The processed images are grouped by date in Figs. 3 to 13, together with the relevant synoptic weather charts and meteorological and tidal data that help in their interpretation. The organization of those figures is as shown in Table 2.

TABLE 1

NOAA7 AVHRR DATA PROCESSED

Date	Orbit (Dundee number)
8 August 1983	10957
16 August 1983	11070
26 August 1983	11211
7 September 1983	11381
12 September 1983	11451
17 September 1983	11522
2 October 1983	11734
10 October 1983	11847
19 October 1983	11974
20 October 1983	11988

1 IMAGE COLLECTION AND PROCESSING

In the summer of 1983 SACLANTCEN's MARIA PAOLINA G. (MPG) and the Italian Hydrographic Institute's AMMIRAGLIO MAGNAGHI conducted several oceanographic and acoustic research cruises in the Alboran Sea [1,2].

During the first cruise, in August 1983, SACLANTCEN's satellite data acquisition system [3] was embarked on the MPG. This system could receive images from (TIROS-N/NOAA7) satellites in Automatic Picture Transmission (APT) format for visual presentation and analysis. The purpose was to assist in determining the areas in which to collect oceanographic data and to locate suitable positions for launching current floats.

It should be noted that although the infrared (IR) radiation recorded by the satellites is related to a very thin sea surface film only about 50 microns thick, in many cases it suggests the deeper oceanic situation. Because of the oceanographic measurements and observations made we can say that the circulation as seen by the satellites is similar to that of the first tens of metres of water depth. During the summer of 1983 the images in APT format were received directly at the Centre. During the same period numerous images were requested and received for selected days from the University of Dundee, Scotland, which has a receiver station for TIROS-N/NOAA7 series satellites in High Resolution Picture Transmission (HRPT) format.

Figures 3 to 13, a through m, contain meteorological and tidal data (a,b), the original distorted images (c,d,e,f), the Mercator-transformed images (g,h,i,j) and apparent sea surface temperatures (k,m). However these temperatures are the radiation temperatures measured at the satellite height, and may be up to a few degrees colder than the true sea surface temperature due to the effect of the intervening atmosphere.

These data were processed and analyzed using the Satellite Analysis and Research System (STARS) software developed at the Centre [3]. Only diurnal orbits were considered so as to allow the use of channels operating both in the visible and near-infrared wavebands and in the thermal infrared wavebands.

Four channels have been examined for the HRPT images. Their functions are described below [4]:

Channel 1 was used for daytime mapping of clouds and earth surface features.

Channel 2 was used primarily for daytime delineation of coasts. (Clouds and earth surface features are visible.)

Channels 4 and 5 were used during both day and night because of their response to the peak radiation emitted by the earth and its atmosphere and because they are not affected by reflected solar radiation. It must be remembered that sea surface temperature measurements are attenuated by atmospheric water vapour.

The images obtained from these channels are presented in parts c-f of Figs. 3, 4, 6, 9, 10, 11, 12 and 13.

(Channel 3 was not used because it is susceptible to contamination by reflected solar radiation during the day.)

Channels 2 and 4 were also used for the APT analysis:

Channel 2 was used for the near-infrared band.

Channel 4 was used for the thermal infrared band.

The images obtained from these channels are presented in parts c-f of Figs. 5, 7, 8.

To compare the APT images received on board ship with those of the HRPT system, Figs. 5d and 5e show the APT images in Channels 2 and 4, respectively, on 16 August 1983. The corresponding HRPT images are presented in Figs. 4d and 4e respectively. The Channel 2 image of Fig. 5d indicates the presence of considerable (electro-magnetic) noise in the western part of the Alboran Sea; the Channel 4 image of Fig. 5e, on the other hand, shows the effect of filtering.

2 TRANSFORMATION TO MERCATOR PROJECTION

Most of the High-Resolution Picture Transmission (HRPT) images were transformed to a Mercator projection with a scale of 1 km/pixel at 36°N by using identifiable points on the coast. This was done on an HP-1000 computer using a "Navigation Subsystem" software and a library of "Ground Control Points" (GCP) [5].

The transformation offers two advantages:

a) All the images are on the same scale and mid-latitude at the end of the analysis, and can thus be superimposed if desired.

b) The positions of such features as water masses and fronts can be identified by latitude and longitude, as on a normal chart. This can allow useful oceanographic knowledge to be communicated quickly to other units in a joint experiment or from a laboratory to a research ship (or vice versa). It can also allow precise plotting of any movement of the oceanographic features.

Such transformations are presented in parts g-h of Figs. 3, 10, 11, 12 and 13. As an example of the accuracy of the transformation to a Mercator projection, a chart to the same scale and mid-latitude was prepared on a Sperry Univac 1100/60H1 computer (Fig. 13h).

3 APPLICATION TO OCEANOGRAPHIC STUDIES

3.1 Water Masses

The disposition of the various masses of water entering and leaving the Mediterranean can be seen on these images. For example it is possible to follow the movements of the thermal front south of Capo de Geta (northeastern limit of the Alboran Sea) both westwards and eastwards. This demonstrates how the cold and less-saline water of the Atlantic runs east along the African coast once it has entered the Mediterranean and shows the size of the mixing zones between the cold and warm waters.

3.2 Temperature profiling

An important by-product of the technique is the capability to produce temperature profiles across the observed region. As examples, two latitudinal and five longitudinal profiles are presented for each day (parts k and m of Figs. 3 to 13).

The profile locations are the same for all readings and therefore provide a good means of comparing the temperature variability among points in the Alboran Sea. It should be noted that none of the temperatures shown in the images have been corrected for the presence of water vapour, which attenuates the emitted infrared radiation.

3.3 Comparison with Synoptic Weather Charts and Tidal Data

The diurnal satellite images presented in Figs. 3 to 13 can be compared with the contemporary synoptic meteorological observations. A copy of the corresponding 1200 GMT surface synoptic weather chart of the European Meteorological Bulletin (published by the West German Meteorological Services [6]) for each date has therefore been inserted as part a of each figure. The relevant meteorological data recorded at Gibraltar and Oran (at the western and eastern ends of the Alboran Sea respectively) are listed in part b of each figure.

Knowledge of the meteorological fields over the sea is important for the correct interpretation of the images, especially when quantitative use is being made of the data. For example, in areas of low wind speed the surface temperature field measured by satellite (including a correction for the atmospheric effects), may show higher values in the afternoon, due to the effect of a diurnal thermocline, and not reflect the temperature value of the underlying "mixed layer".

Satellite data can be used, together with the meteorological fields, to estimate the turbulent heat fluxes between sea and atmosphere. To give a slight indication of the general distribution of water vapour in the Alboran Sea area on the days studied, the relative humidities and calculated dew points [7] at Gibraltar and Oran have been included in the meteorological data.

The Gibraltar tide predictions [8] are included in part b of each figure, because the tidal flow might help to explain some of the water movements observed on the images.

CONCLUSIONS

The contents of this Atlas give an idea of what can be obtained from a sequential analysis of images in both the HRPT images and APT formats.

The future application of this work will continue to depend on a correct understanding of these techniques by researchers.

The results of the acoustic runs carried out across these different water masses should be compared with satellite data to enhance its applicability to oceanographic and underwater acoustic studies. This study shows how a systematic analysis of images can be performed. This can be done in advance of oceanographic and underwater acoustics field studies to allow for the selection of the best areas for investigation, based on the distribution of water masses, thermal fronts, and other ocean characteristics.

REFERENCES

1. PISTEK, P. Deep water mass circulation in the western Alboran Basin: measurements in July and September 1980 (ALBORAN I), SACLANTCEN SR-81. La Spezia, Italy, SACLANT ASW Research Centre, 1984. [AD A 148 566]

2. PISTEK, P. Deep water mass circulation in the western Alboran Basin: measurements in January to April 1982 (ALBORAN II). SACLANTCEN document in preparation.

3. WANNAMAKER, B. A system for receiving and analyzing meteorological satellite data at small meteorological/oceanographic centres or aboard ship, SACLANTCEN SR-74. La Spezia, Italy, SACLANT ASW Research Centre, 1983. [AD A 137 215]

4. FETT, R.W., BOHAN, W.A., BATES, J.J. and TIPTON, S. Navy tactical applications guide, operational environmental satellite; polar-orbiting satellites and geostationary satellites; spacecraft, sensors, imagery, NAVENVPREDRSCHFAC TR 83-02 Monterey CA, Naval Environmnental Prediction Research Facility, 1983.

5. WANNAMAKER, B., and NACINI, E. A directory of European, Middle Eastern and N. African coastal ground control points for mapping satellite images, SACLANTCEN SM-170. La Spezia, Italy, SACLANT ASW Research Centre, 1984. [AD 142 019]

6. European Meteorological Bulletin. Offenbach, W. Germany. Deutscher Wetterdienst Zentralamt.

7. TABELLE PER DETERMINATE L'UMIDITA' RELATIVA E LA TEMPERATURA DI RUGIADA O DI BRINA MEDIANTE LO PSICROMETRO. AERONAUTICA MILITARE Italiana. Ispettorato delle telecomunicazioni e dell'assistenza al volo. Servizio meteorologico, 1979.

8. ISTITUTO IDROGRAFICO DELLA MARINA. Tavole di marea e delle correnti di marea. Genova, Italy, 1983.

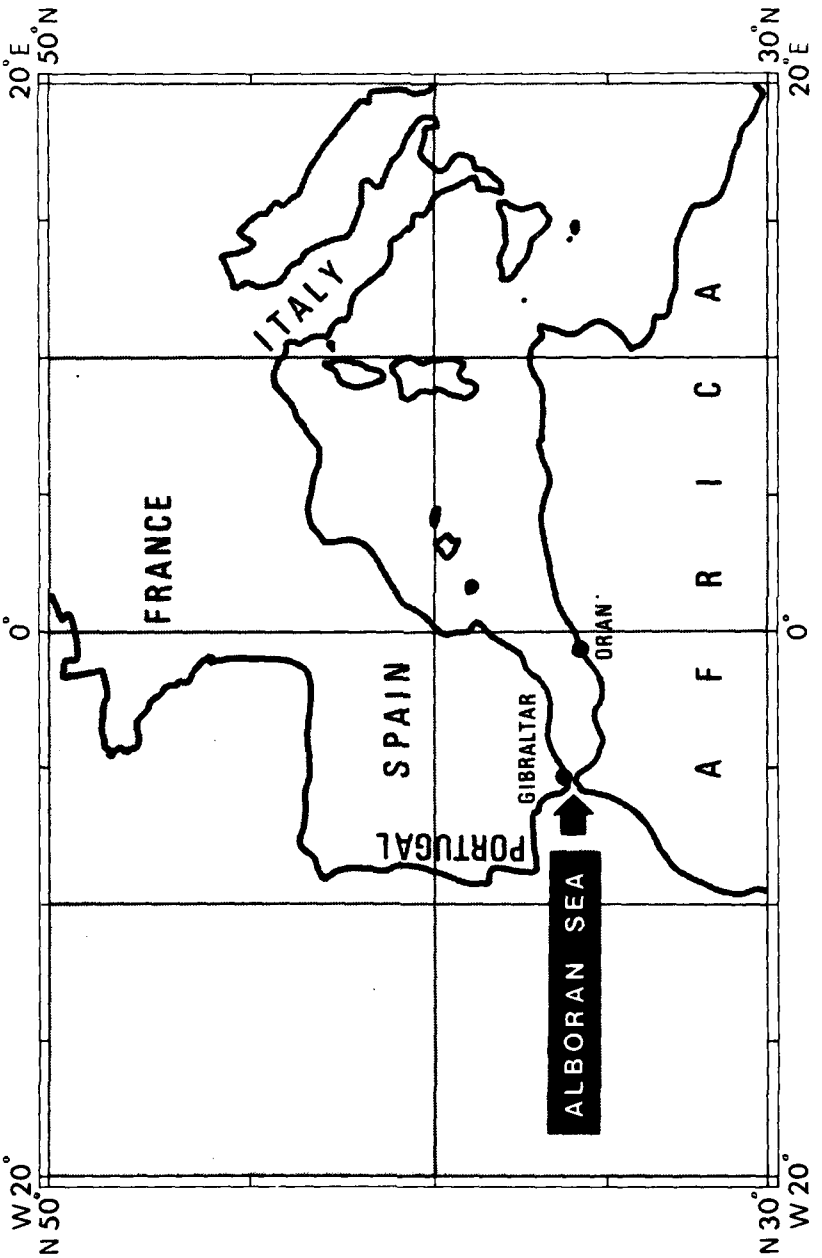


FIG. 1 LOCATION OF THE ALBORAN SEA.

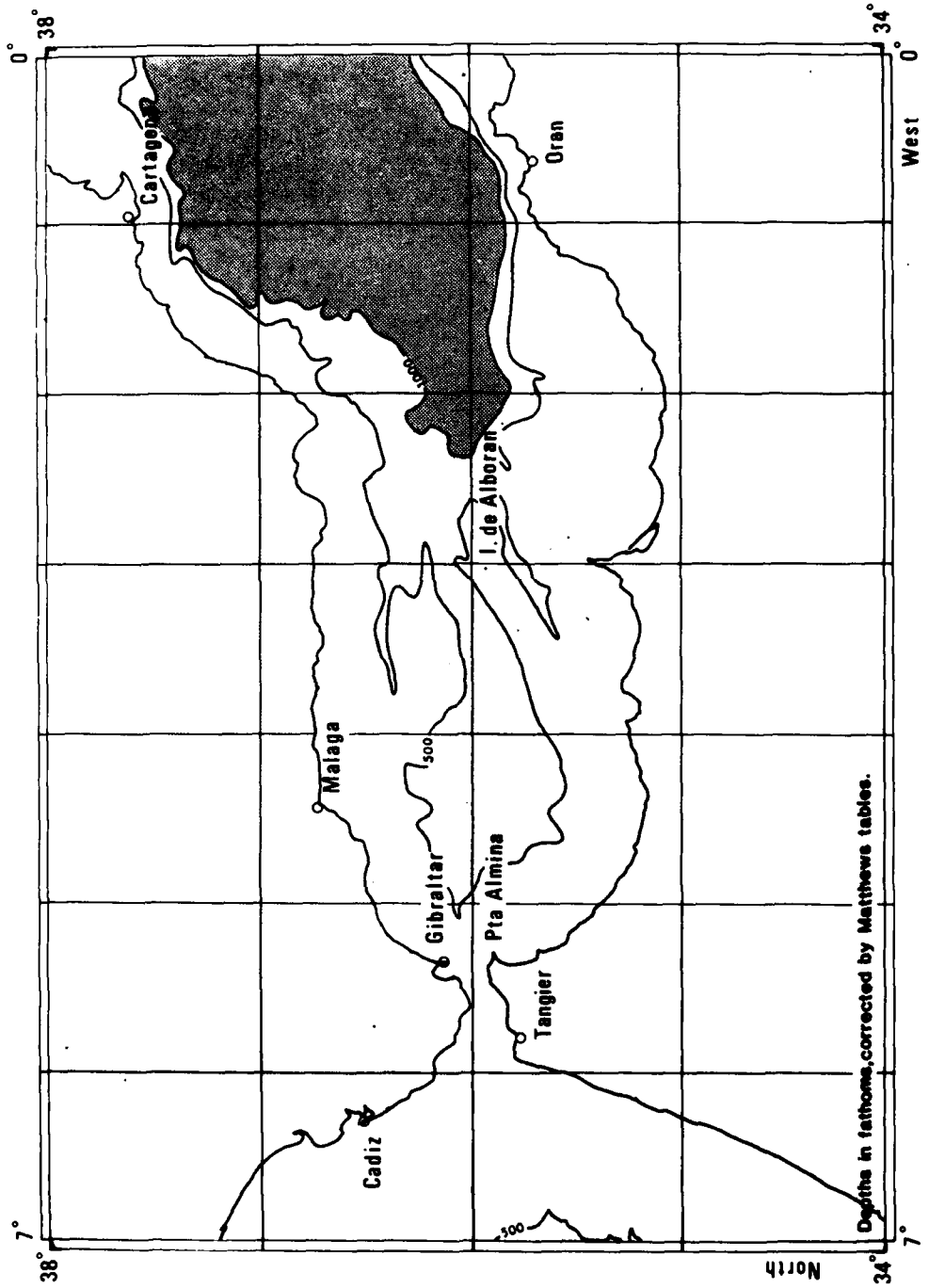


FIG. 2 BATHYMETRY OF THE ALBORAN SEA.

Fig. 3

8 AUGUST 1983

HRPT Data

Orbit 10957 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d*
e*
f*

Mercator-transformed Images

g Channel 1 visible/near-infrared
h Channel 2 near-infrared
i Channel 4 thermal infrared
j Channel 5 thermal infrared

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

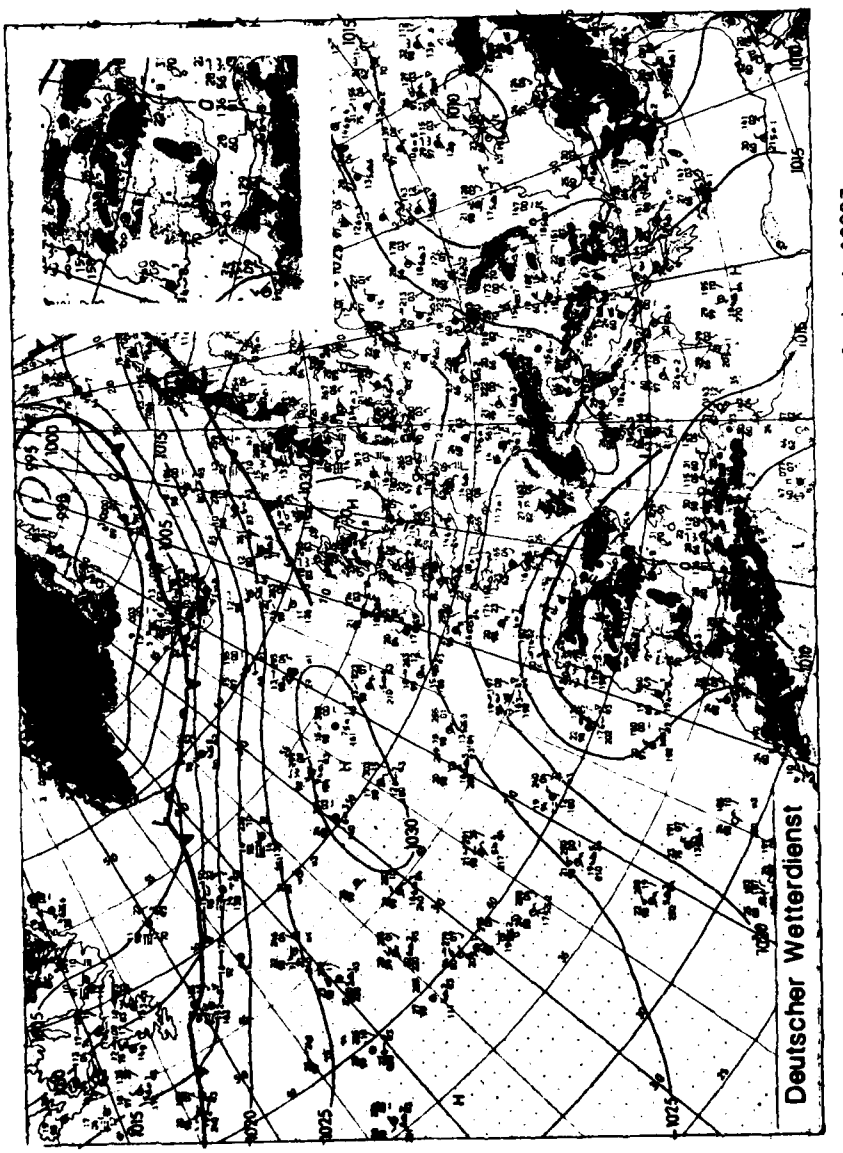


FIG. 3a 8 AUGUST 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

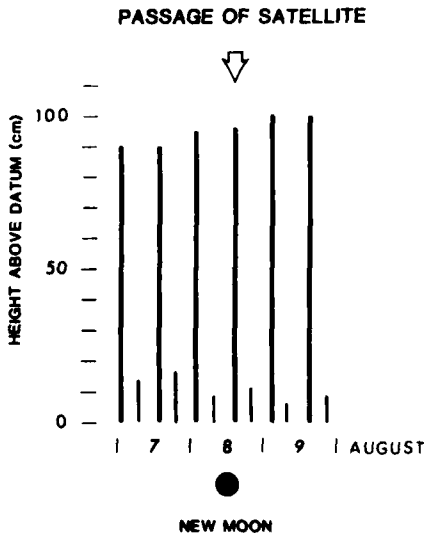
GIBRALTAR (1200Z)

WIND	: WSW 10 kn
CLOUD	: Cumulus Mediocris or Cumulus Congestus
COVERAGE	: 3/8
VISIBILITY	: 20 km
TEMPERATURE	: 25°C
DEW POINT	: 15°C
RELATIVE HUMIDITY	: 54%

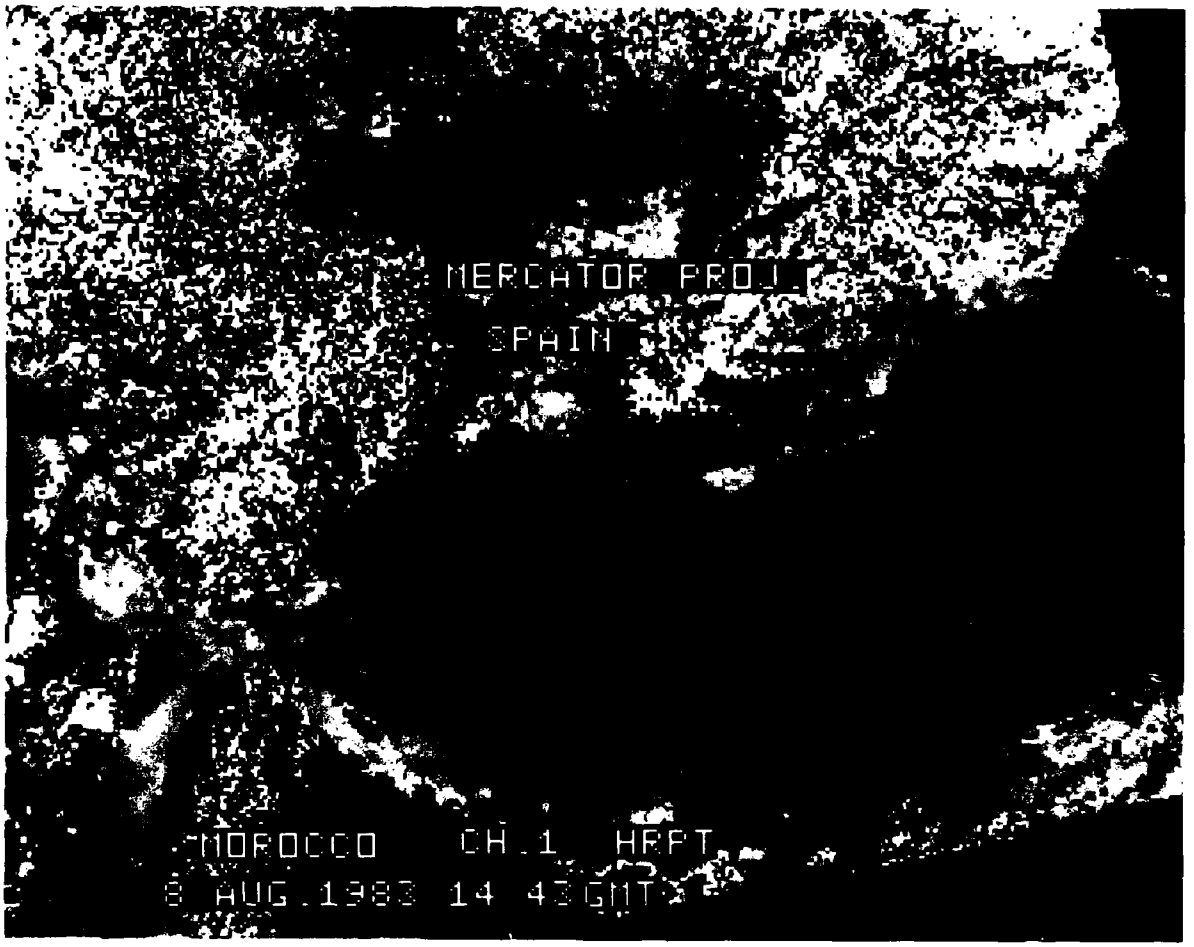
ORAN (1200Z)

WIND	: W 10 kn
CLOUD	: Stratocumulus
COVERAGE	: 5/8
VISIBILITY	: 10 km
TEMPERATURE	: 28°C
DEW POINT	: 20°C
RELATIVE HUMIDITY	: 61%

HIGH AND LOW TIDES GIBRALTAR



3b 8 August 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

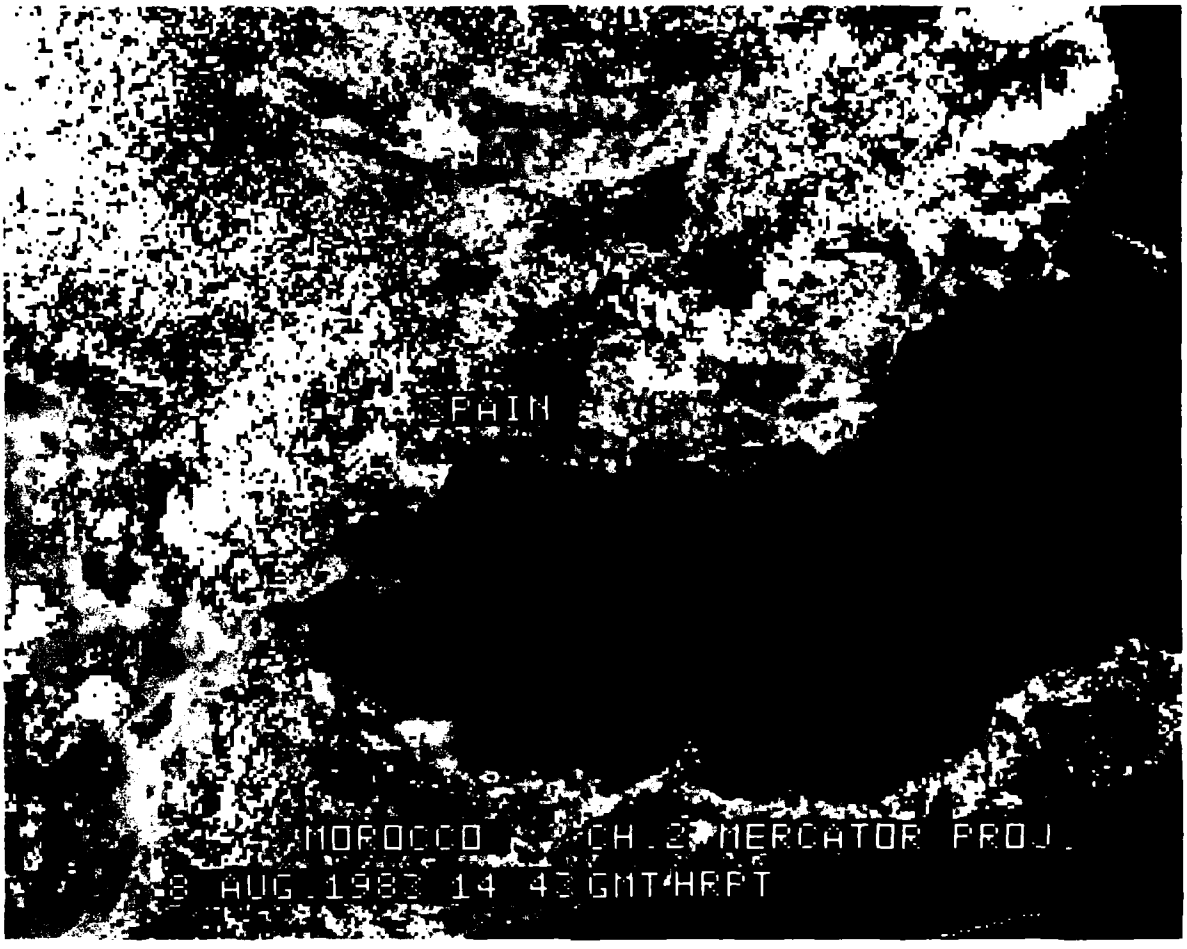


3g 8 August 1983
HRPT Channel 1, visible/near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis Cloud and haze east of Gibraltar and towards the south-south-east along the Moroccan coast. West of the Strait of Gibraltar the sea is covered by cloud and haze.



3h 8 August 1983
HRPT Channel 2, near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used to identify coastal points for use in the transformation process.

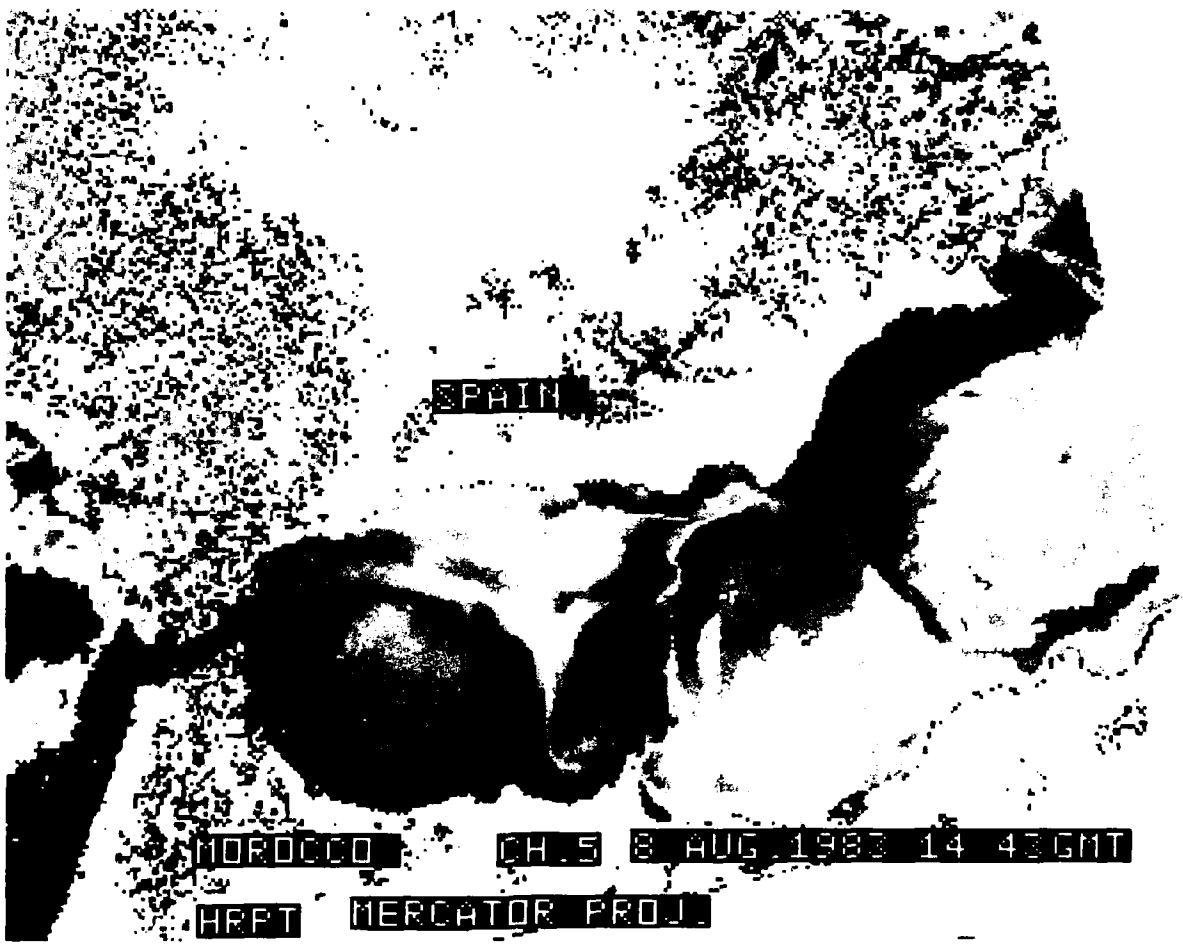
Analysis Cloud and haze east of Gibraltar and towards the south-south-east along the Moroccan coast. West of the Strait of Gibraltar the sea is covered by cloud and haze.

3i 8 August 1983
HRPT Channel 4, thermal infrared

Transformed to Mercator projection (north at top)

Methodology Some temperatures of the different water masses are plotted; they are not corrected for atmospheric attenuation.

Analysis The circulation of cold water eastward of Gibraltar and towards the south-south-east along the Moroccan coast is partly falsified by cloud and haze.



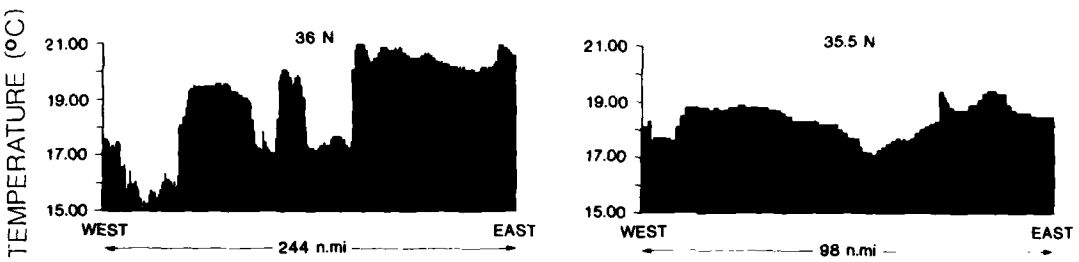
3j 8 August 1983
HRPT Channel 5, thermal infrared

Transformed to Mercator projection (north at top)

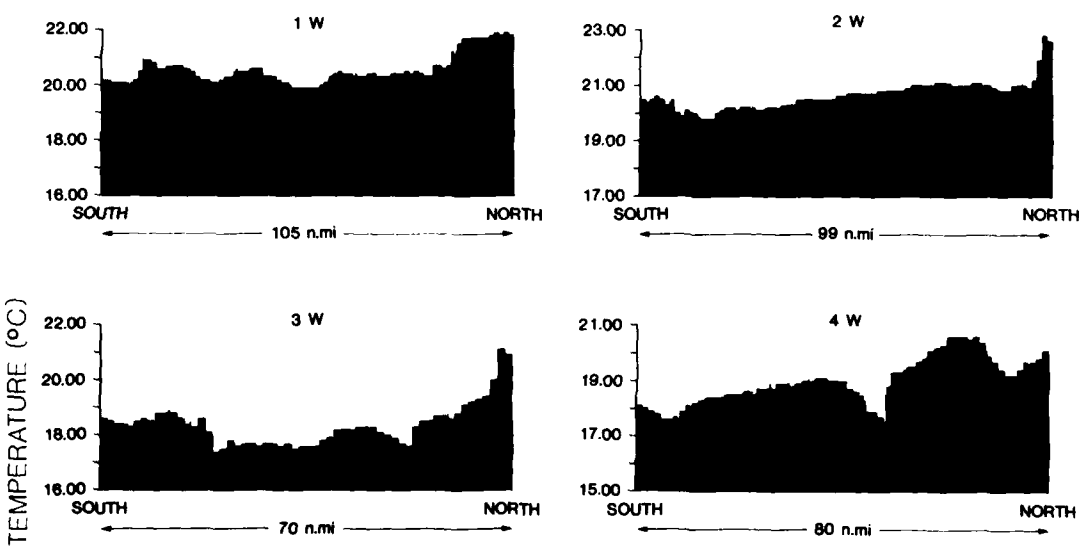
Methodology ---

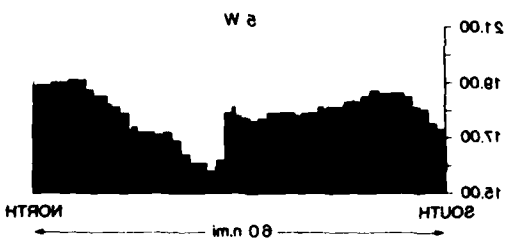
Analysis The circulation of cold water east and south-south-east of Gibraltar is partly falsified by cloud and haze. Thermal fronts are evident.

LATITUDINAL TEMPERATURE PROFILES



LONGITUDINAL TEMPERATURE PROFILES

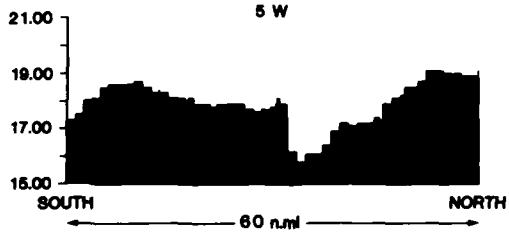


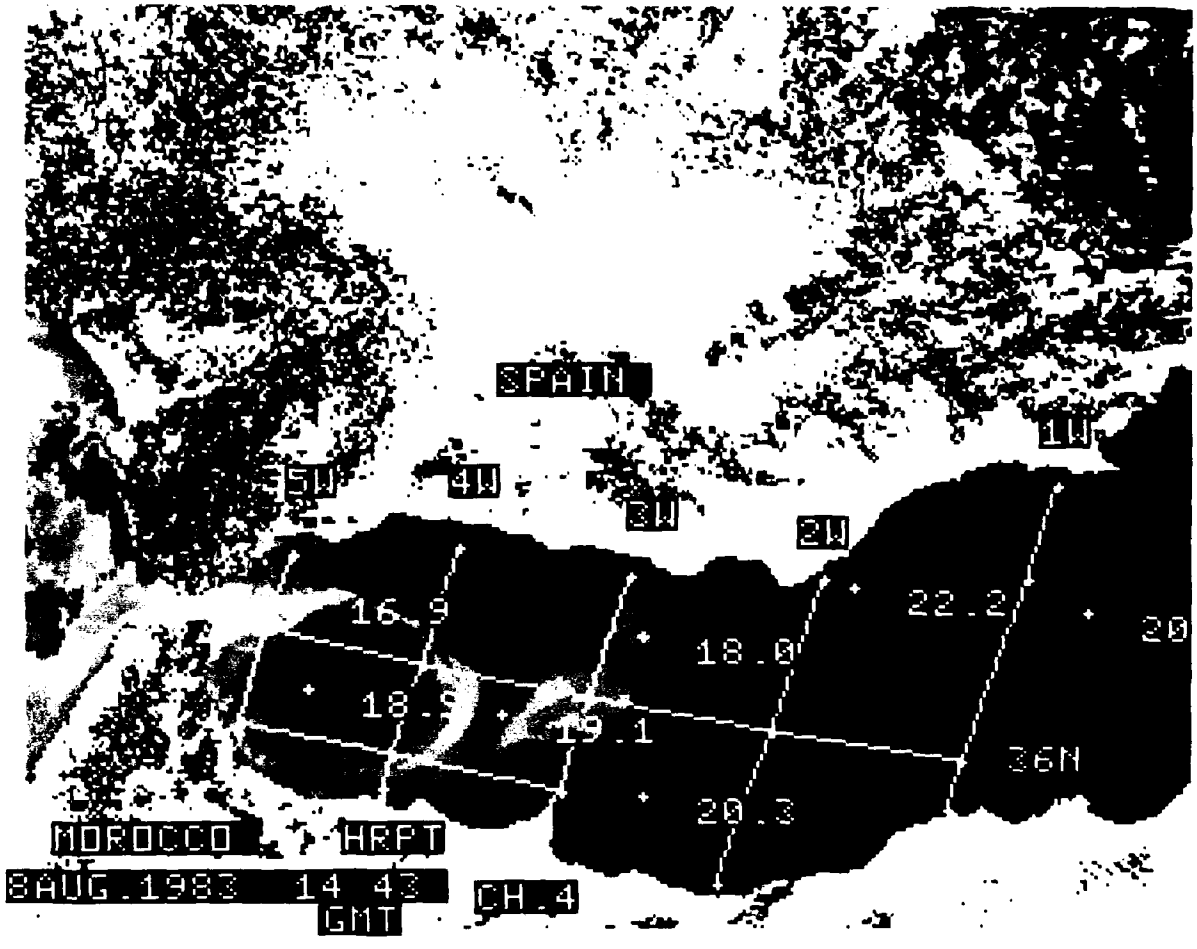


3k 8 August 1983
Temperature profiles along tracks shown in Fig. 3m
(not corrected for atmospheric attenuation)

ERRA.JM

The bottom illustration on page 24 has inadvertently been reproduced in mirror image. The following is the correct version:





3m 8 August 1983
HRPT Channel 4, thermal infrared

Original distorted image showing tracks of temperature profiles presented in Fig. 3k

Methodology Some temperatures of the different water masses are plotted; they are not corrected for atmospheric attenuation.

Analysis The circulation of cold water eastward of Gibraltar and towards the south-south-east along the Moroccan coast is partly falsified by cloud and haze.

Fig. 4

16 AUGUST 1983

HRPT Data

Orbit 11070 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d Channel 2 near-infrared
e Channel 4 thermal infrared
f*

Mercator-transformed Images

g*
h*
i*
j*

Sea-surface Temperatures

k*
m*

*Not provided.

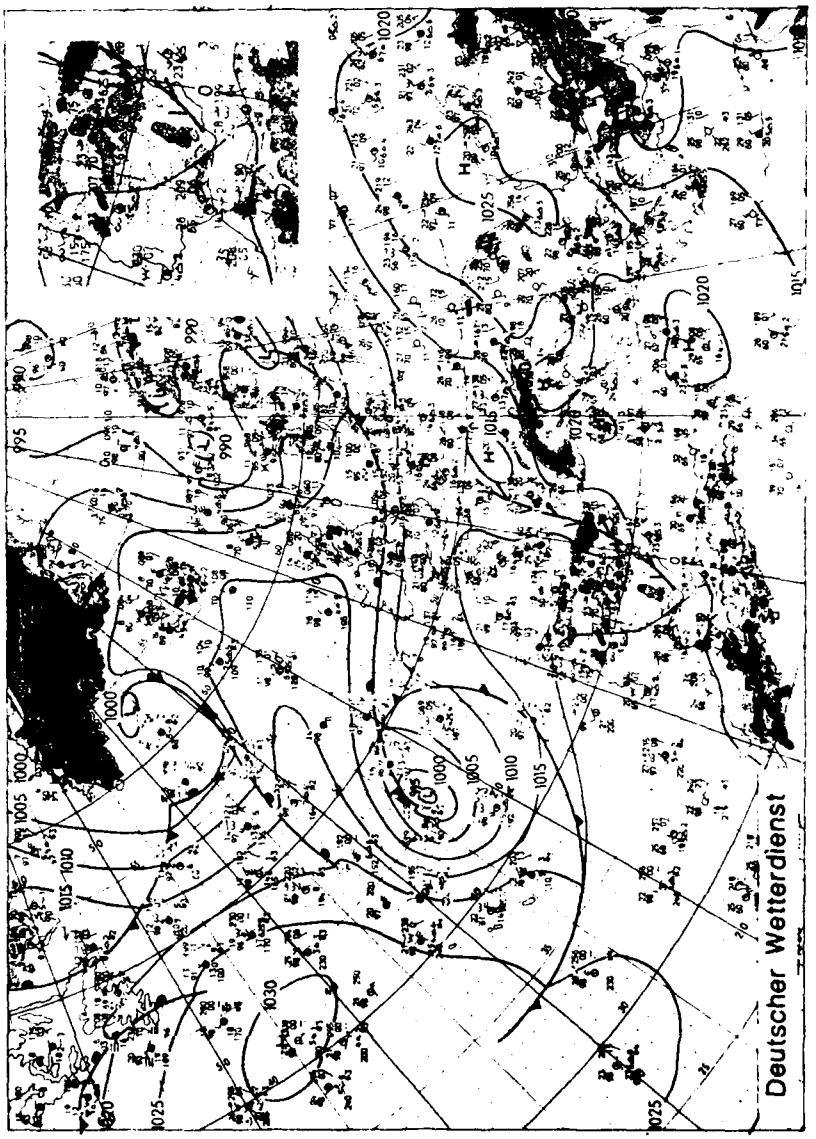


FIG. 4a 16 AUGUST 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

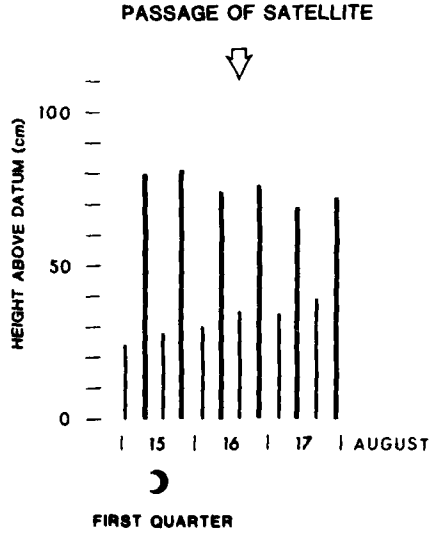
GIBRALTAR (1200Z)

WIND	: W 10 kn
CLOUD	: Stratocumulus
COVERAGE	: 2/8
VISIBILITY	: 15 km
TEMPERATURE	: 26°C
DEW POINT	: 14°C
RELATIVE HUMIDITY	: 48%

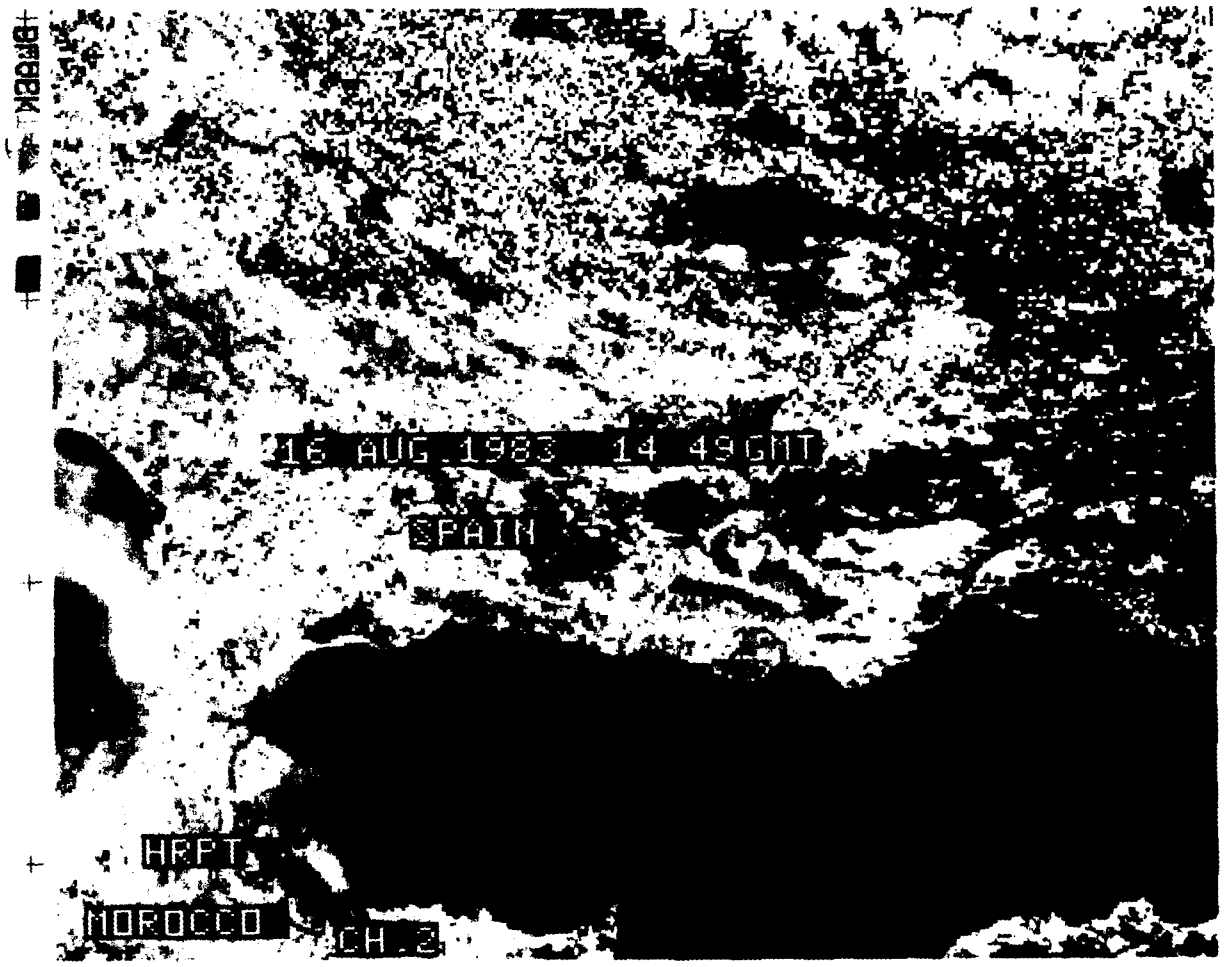
ORAN (1200Z)

WIND	: SW 20 kn
CLOUD	: Cirrus Spissatus-Altocumulus Translucidus
COVERAGE	: 7/8
VISIBILITY	: 10 km
TEMPERATURE	: 28°C
DEW POINT	: 12°C
RELATIVE HUMIDITY	: 38%

HIGH AND LOW TIDES GIBRALTAR



4b 16 August 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

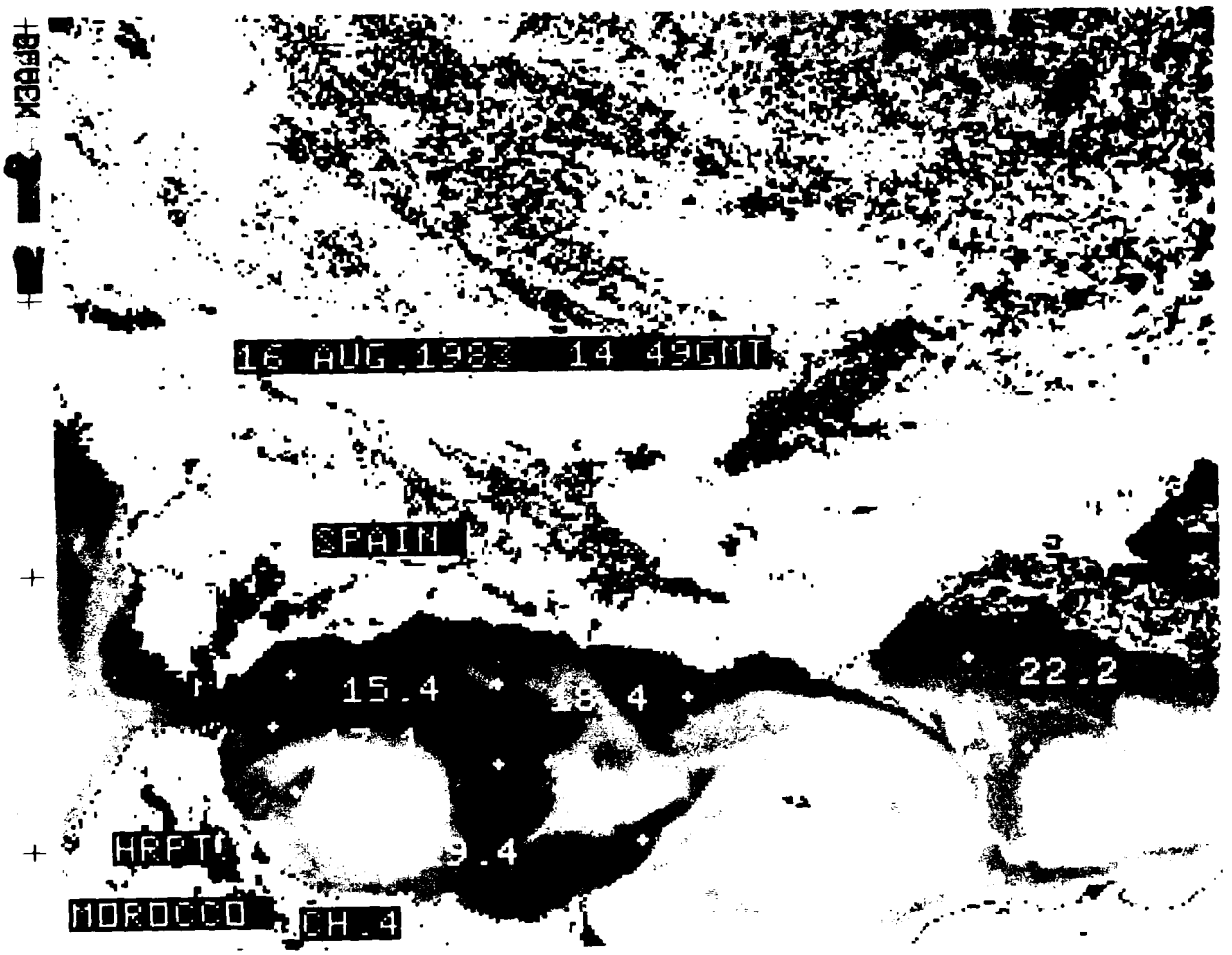


4d 16 August 1983
HRPT Channel 2, near-infrared

Original distorted image

Methodology It was not possible to locate enough coastal points to turn the distorted image into a Mercator projection.

Analysis Cloud and haze lie along the Moroccan coast and the Spanish coast, both east and west of Gibraltar.



4e 16 August 1983
HRPT Channel 4, thermal infrared

Original distorted image

Methodology Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis The circulation of cold water west and east of Gibraltar - both in the southern part of the Alboran Sea along the Moroccan coast and also along the Spanish coast - is partly falsified by cloud and haze.

PREVIOUS PAGE IS BLANK

Fig. 5

16 AUGUST 1983

APT Data

Orbit 11070 (SACLANTCEN)

General

a, b } See Figs. 4a, b

Original Distorted Images

d Channel 2 near-infrared
e Channel 4 thermal infrared

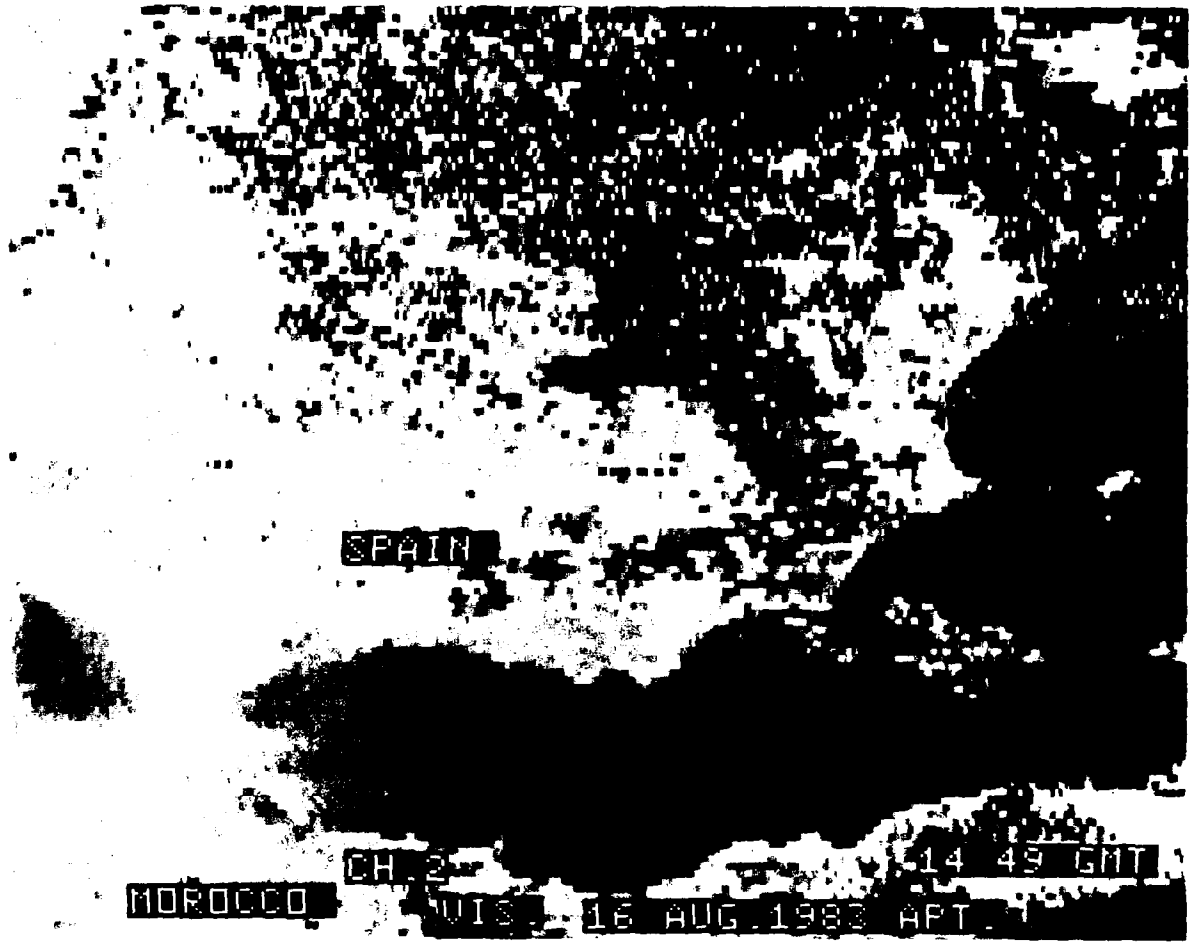
Mercator-transformed Images

h*
i*

Sea-surface Temperatures

k*
m*

*Not provided.

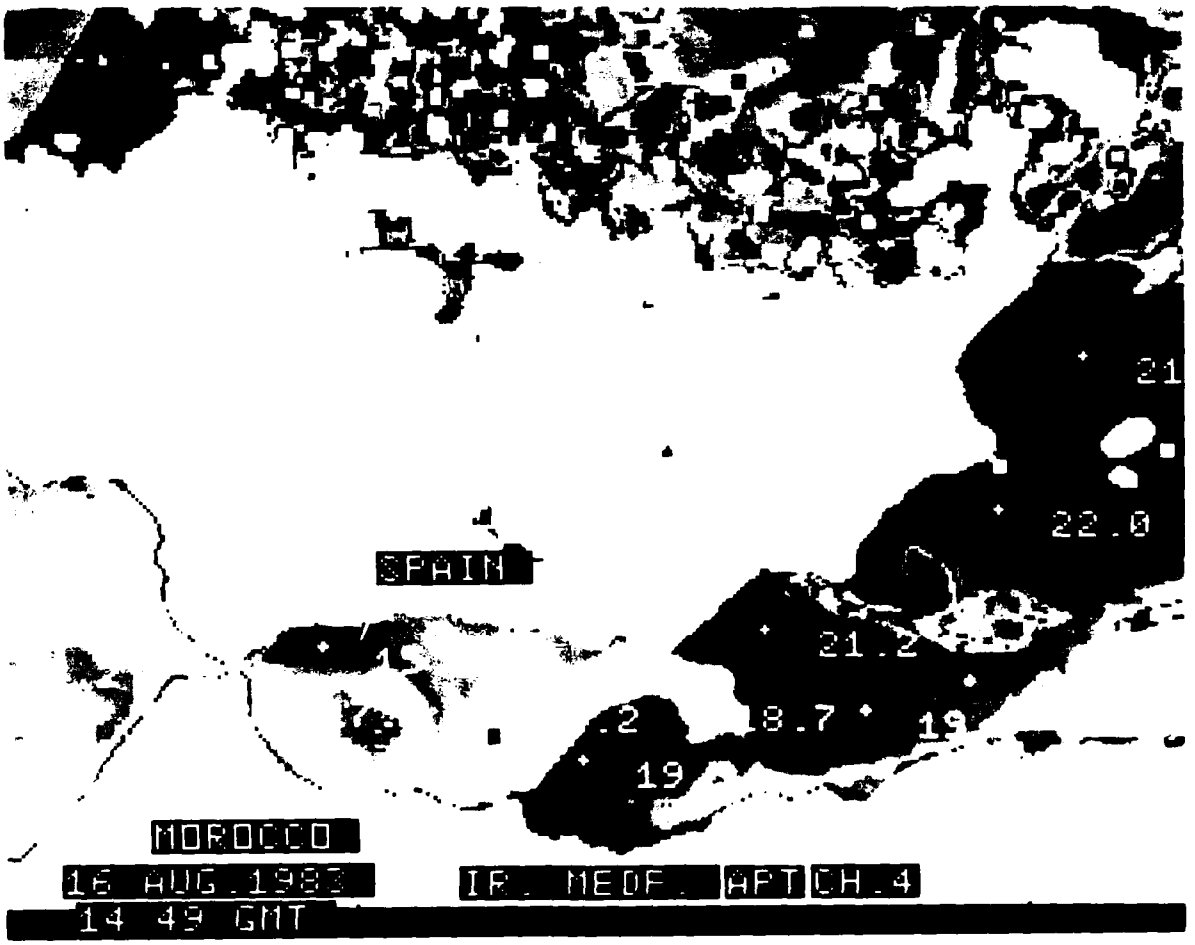


5d 16 August 1983
APT Channel 2, near-infrared

Original distorted image

Methodology The data were noisy. The comparable HRPT system image is given in Fig. 4d.

Analysis Cloud and haze lie along the Moroccan coast and the Spanish coast east and west of Gibraltar.



5e 16 August 1983
APT Channel 4, thermal infrared

Original distorted image

Methodology The data were noisy and have been filtered using a mathematical averaging filter. The comparable HRPT system image is given in Fig. 4e. Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis The circulation of cold water east and west of Gibraltar and in the southern part of the Alboran Sea along the Moroccan coast and along the Spanish coast is partly falsified by cloud and haze.

Fig. 6

26 AUGUST 1983

HRPT Data

Orbit 11211 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d*
e*
f*

Mercator-transformed Images

g*
h*
i*
j*

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

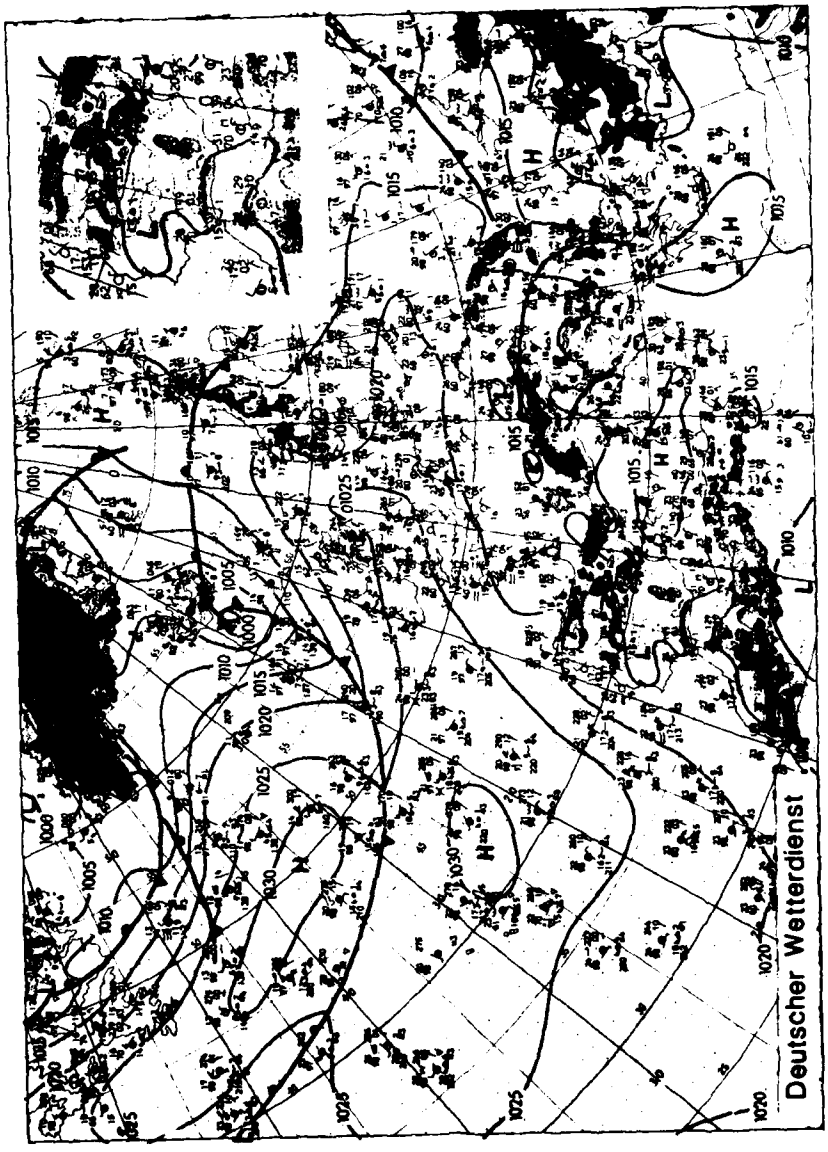


FIG. 6a 26 AUGUST 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

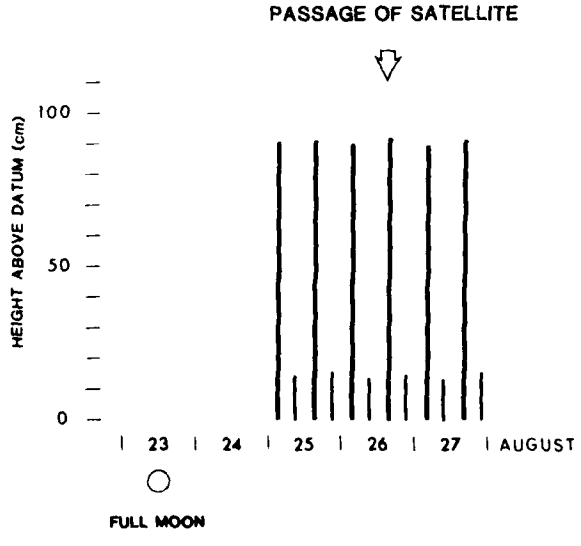
GIBRALTAR (1200Z)

WIND	: WSW 15 kn
CLOUD	: Stratocumulus
COVERAGE	: 1/8
VISIBILITY	: 20 km
TEMPERATURE	: 28°C
DEW POINT	: 15°C
RELATIVE HUMIDITY	: 44%

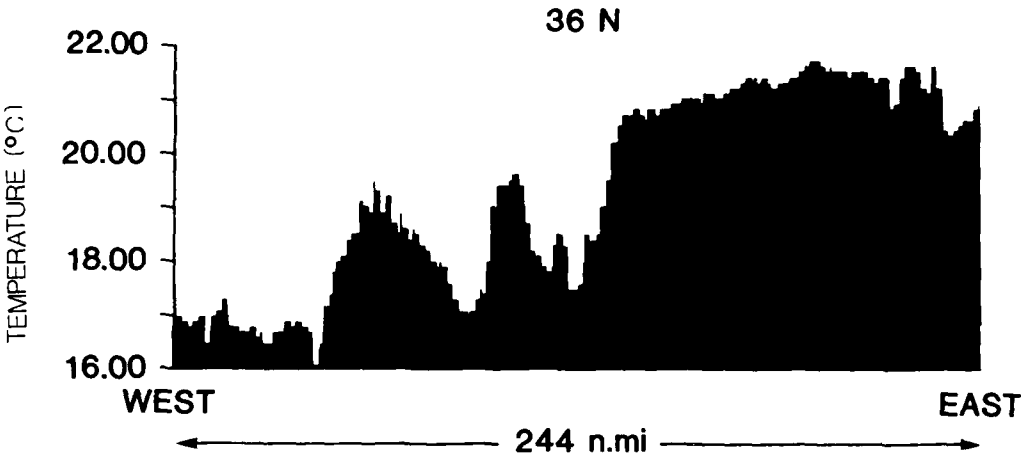
ORAN (1200Z)

WIND	: NNW 15 kn
CLOUD	: ---
COVERAGE	: 1/8
VISIBILITY	: 20 kn
TEMPERATURE	: 31°C
DEW POINT	: 14°C
RELATIVE HUMIDITY	: 36%

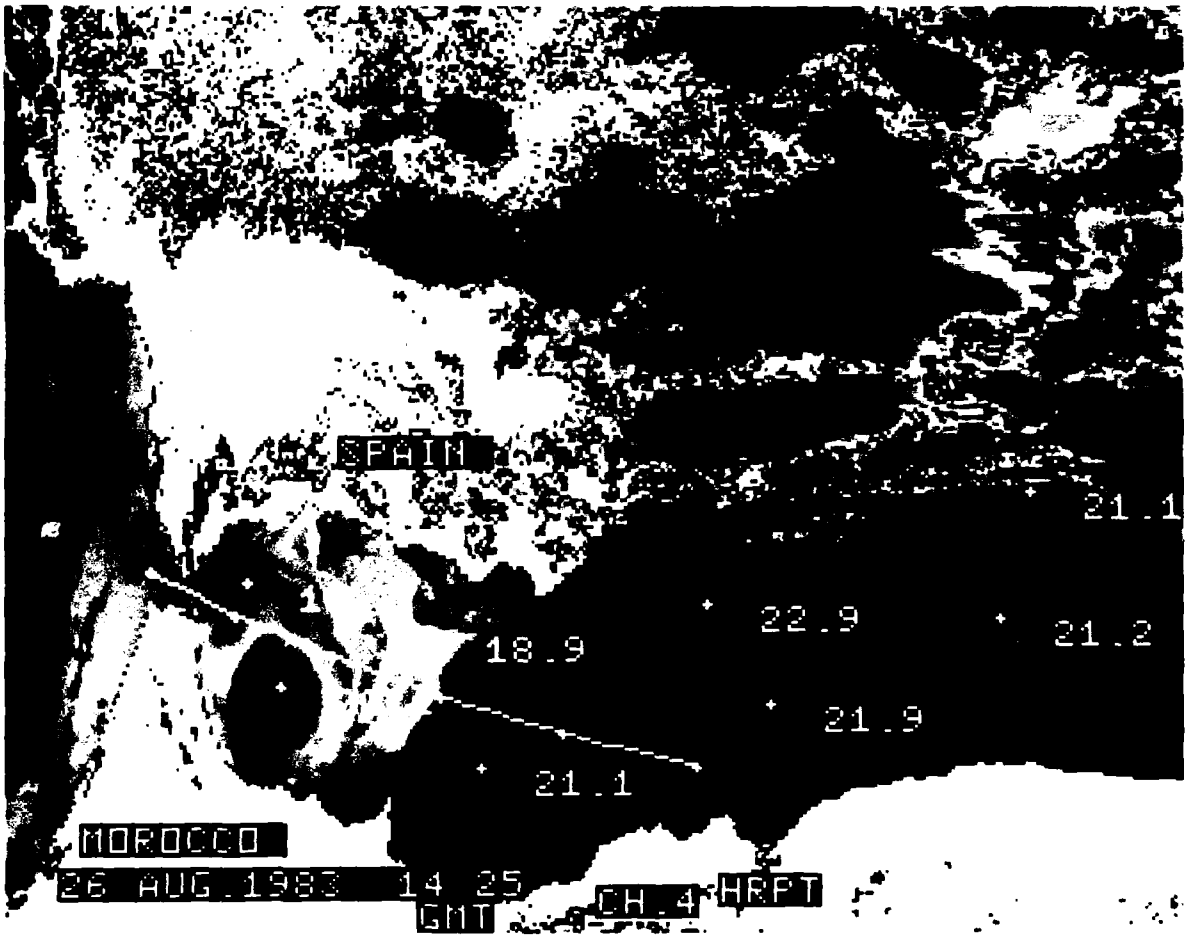
HIGH AND LOW TIDES GIBRALTAR



6b 26 August 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).



6k 26 August 1983
Temperature profile along track shown in Fig. 6m
(not corrected for atmospheric attenuation)



6m 26 August 1983
HRPT Channel 4, thermal infrared

Original distorted image showing tracks of temperature profiles

Methodology Some temperatures of the different water masses are plotted. They are not corrected for atmospheric attenuation.

Analysis The water circulation and thermal fronts are falsified by haze and dense cloud in the Atlantic and by clouds in the eastern part of the Alboran Sea.

Fig. 7

7 SEPTEMBER 1983

APT Data

Orbit 11381 (SACLANTCEN)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

d*
e Channel 4 thermal infrared

Mercator-transformed Images

h*
i*

Sea-surface Temperatures

k*
m*

*Not provided.

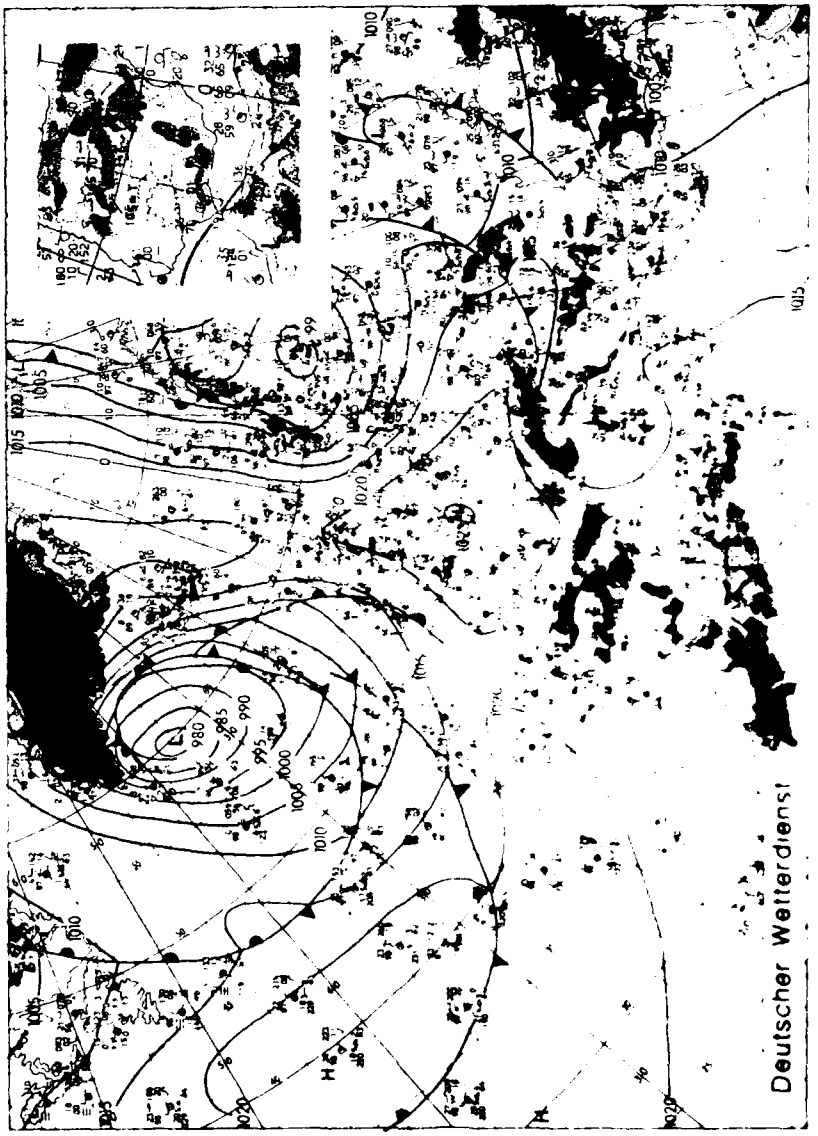


FIG. 7a 7 SEPTEMBER 1988, surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

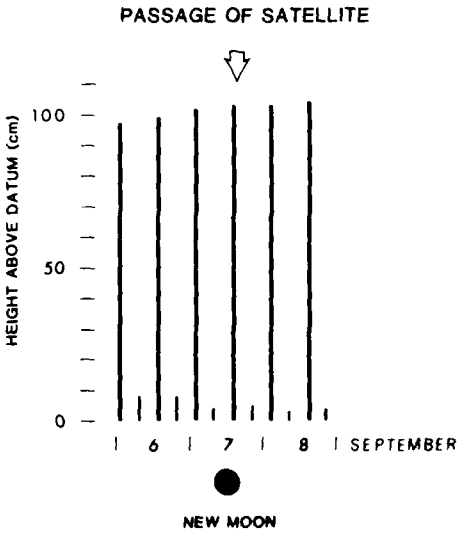
GIBRALTAR (1200Z)

WIND	: E 15 kn
CLOUD	: Cirrus Spissatus-Stratocumulus
COVERAGE	: 1/8
VISIBILITY	: 20 km
TEMPERATURE	: 26°C
DEW POINT	: 19°C
RELATIVE HUMIDITY	: 65%

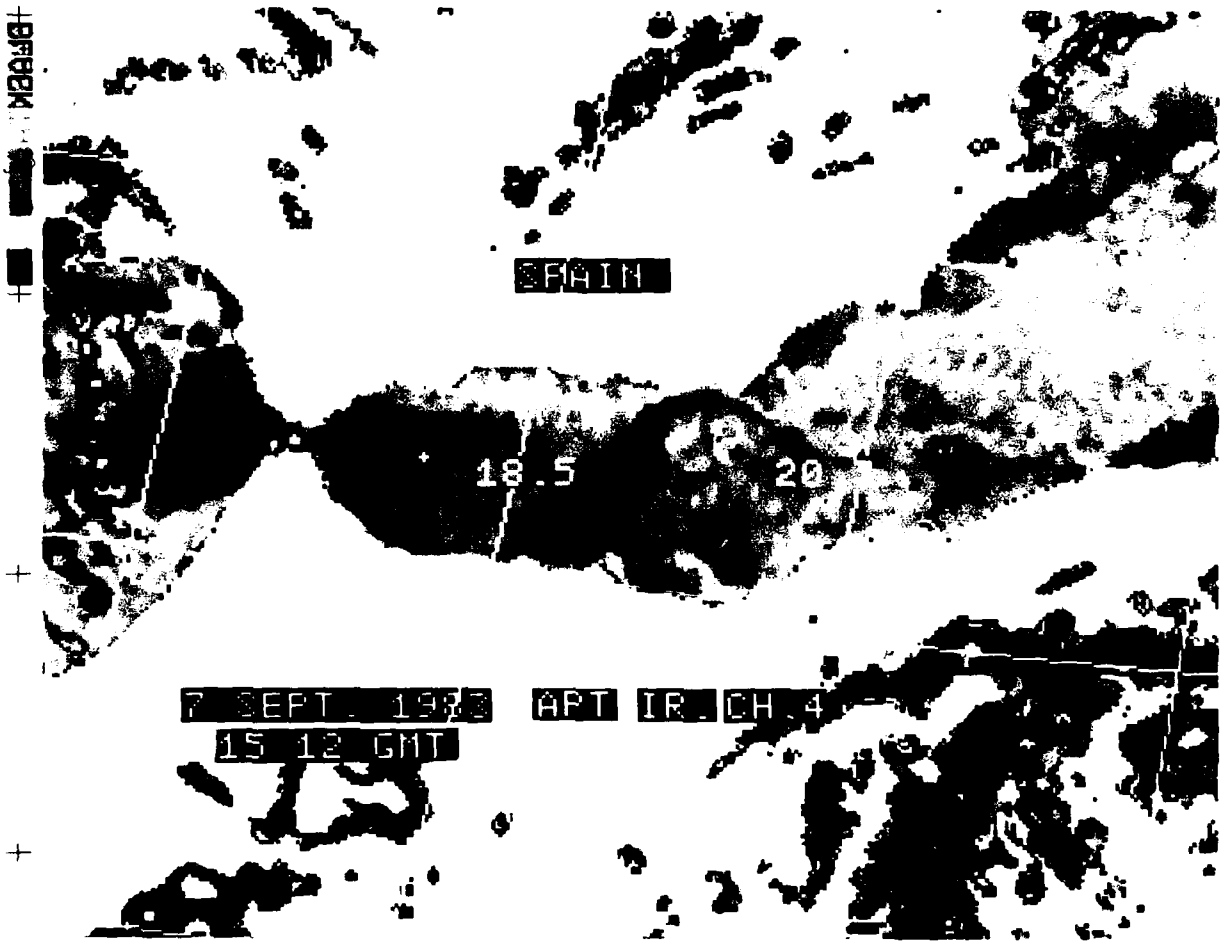
ORAN (1200Z)

WIND	: N 10 kn
CLOUD	: Altocumulus Translucidus-Stratus Nebulosus or Stratus Fractus
COVERAGE	: 2/8
VISIBILITY	: 9 km
TEMPERATURE	: 28°C
DEW POINT	: 24°C
RELATIVE HUMIDITY	: 79%

HIGH AND LOW TIDES GIBRALTAR



7b 7 September 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).



7e 7 September 1983
APT Channel 4, thermal infrared

Original distorted image

Methodology Some specific temperature values are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis Clouds over the Strait of Gibraltar and in the southern part of the basin.

Fig. 8

12 SEPTEMBER 1983

APT Data

Orbit 11451 (SACLANTCEN)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

d*
e Channel 4 thermal infrared

Mercator-transformed Images

h*
i*

Sea-surface Temperatures

k*
m*

*Not provided.

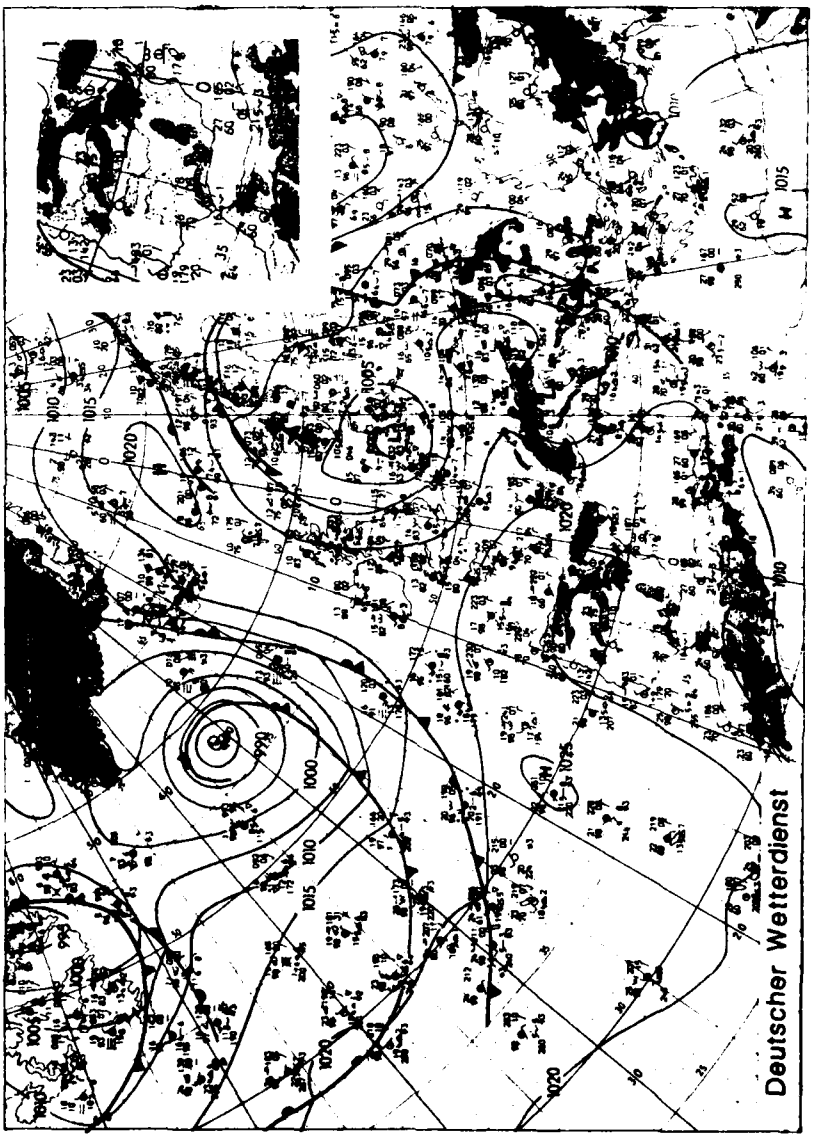


FIG. 8a 12 SEPTEMBER 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

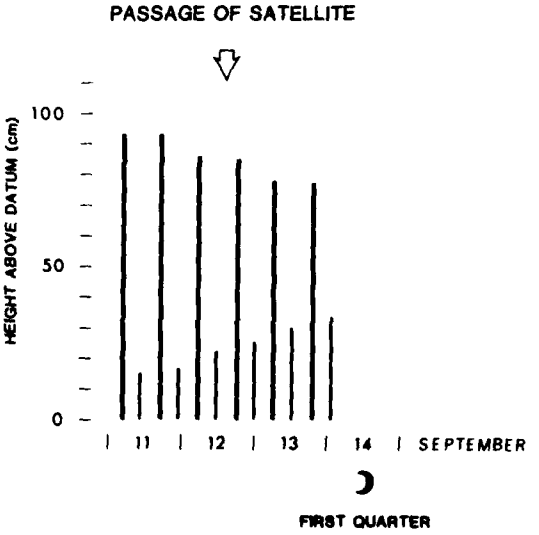
GIBRALTAR (1200Z)

WIND	: SSW 10 kn
CLOUD	: Stratocumulus
COVERAGE	: 1/8
VISIBILITY	: 20 km
TEMPERATURE	: 26°C
DEW POINT	: 16°C
RELATIVE HUMIDITY	: 54%

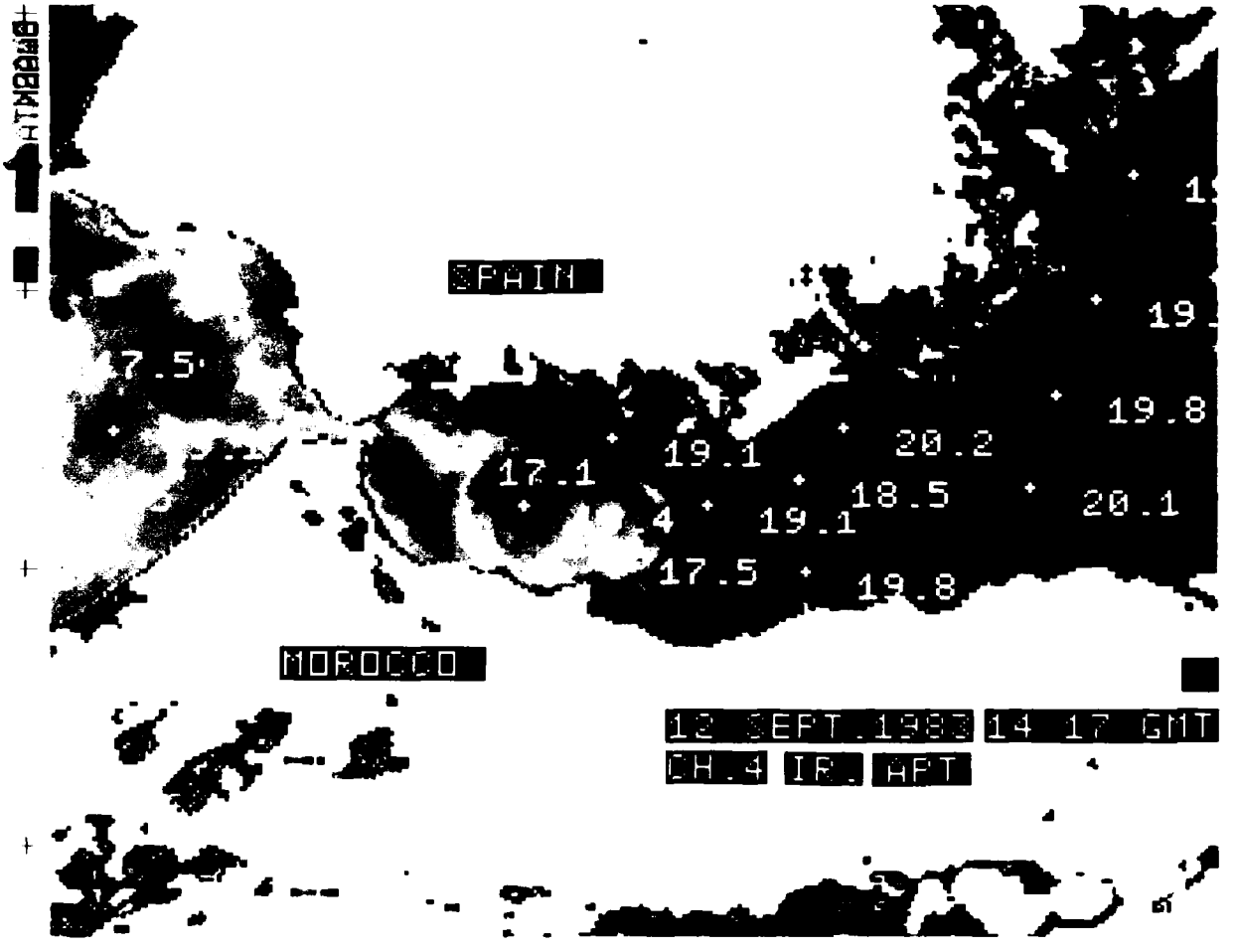
ORAN (1200Z)

WIND	: N 10 kn
CLOUD	: Stratocumulus
COVERAGE	: 3/8
VISIBILITY	: 10 km
TEMPERATURE	: 27°C
DEW POINT	: 21°C
RELATIVE HUMIDITY	: 69%

HIGH AND LOW TIDES GIBRALTAR



8b 12 September 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).



8e 12 September 1983
APT Channel 4, thermal infrared

Original distorted image

Methodology Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis There are clouds along the Spanish coast.

Fig. 9

17 SEPTEMBER 1983

HRPT Data

Orbit 11522 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c Channel 1 visible/near-infrared
d*
e Channel 4 thermal infrared
f Channel 5 thermal infrared

Mercator-transformed Images

g*
h*
i*
j*

Sea-surface Temperatures

k*
m*

*Not provided.

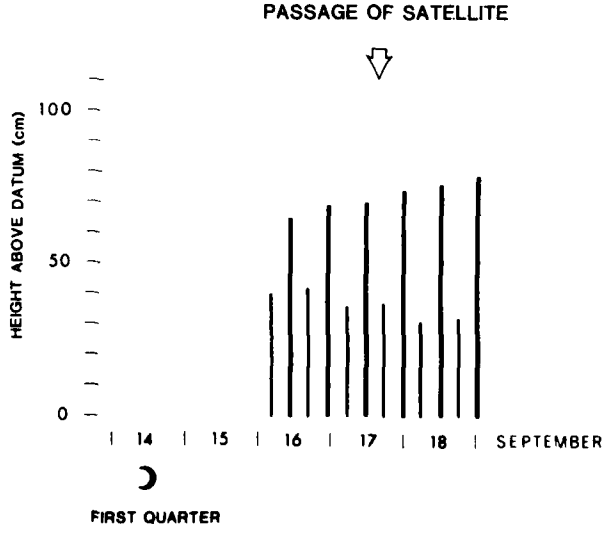
GIBRALTAR (1200Z)

WIND	: SSW 15 kn
CLOUD	: Cirrus Spissatus
COVERAGE	: 2/8
VISIBILITY	: 50 km
TEMPERATURE	: 31°C
DEW POINT	: 12°C
RELATIVE HUMIDITY	: 31%

ORAN (1200Z)

WIND	: N 15 kn
CLOUD	: ---
COVERAGE	: ---
VISIBILITY	: 15 km
TEMPERATURE	: 32°C
DEW POINT	: 8°C
RELATIVE HUMIDITY	: 23%

HIGH AND LOW TIDES GIBRALTAR



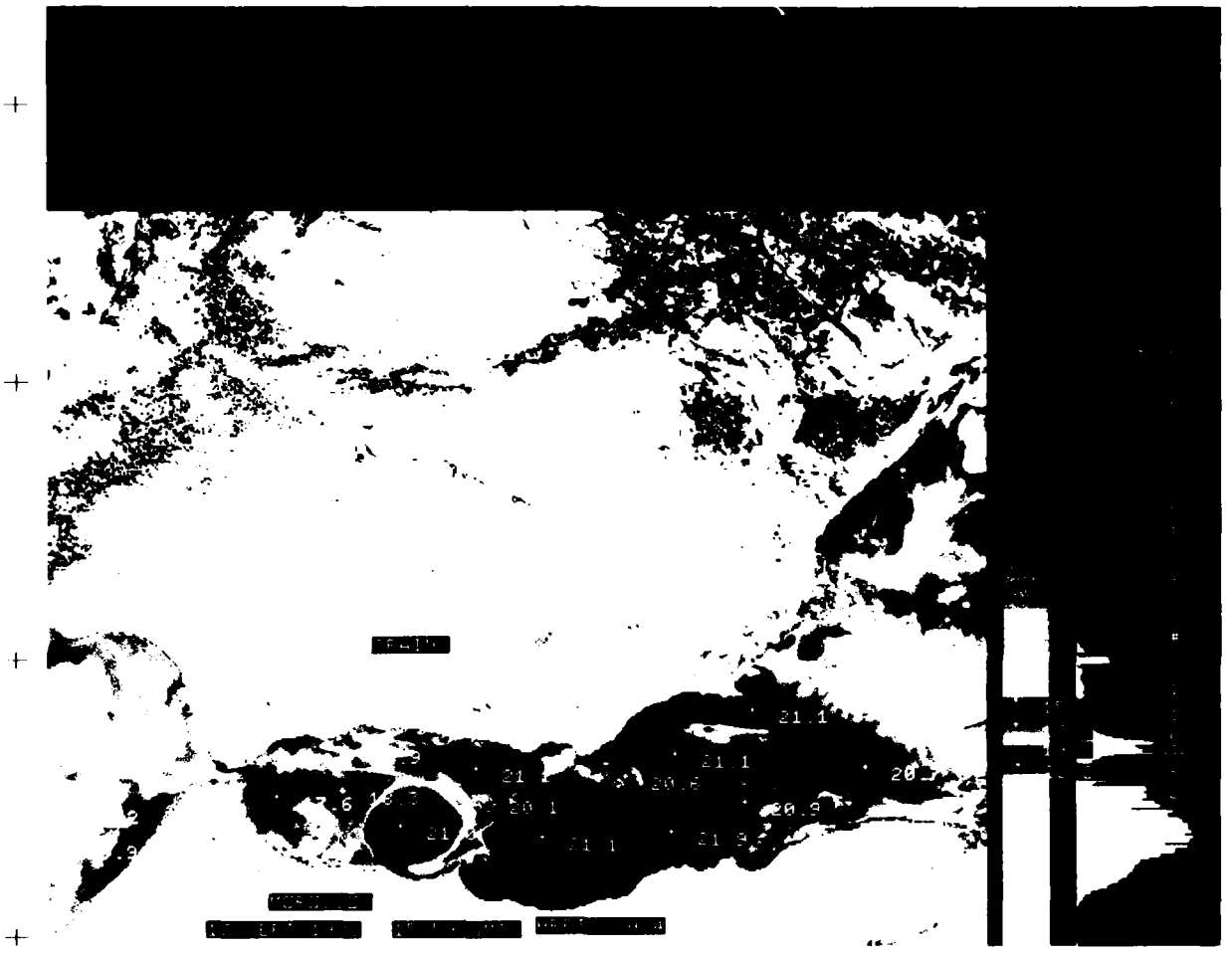
9b 17 September 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

9c 17 September 1983
HRPT Channel 1, visible/near-infrared

Original distorted image

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis The red spot east of the Strait of Gibraltar is worth noting and is caused by sun glitter. The wind observed at Gibraltar is from the south-south-west at 15 kn. The Alboran Sea is free of clouds and the ground-level humidity is low.

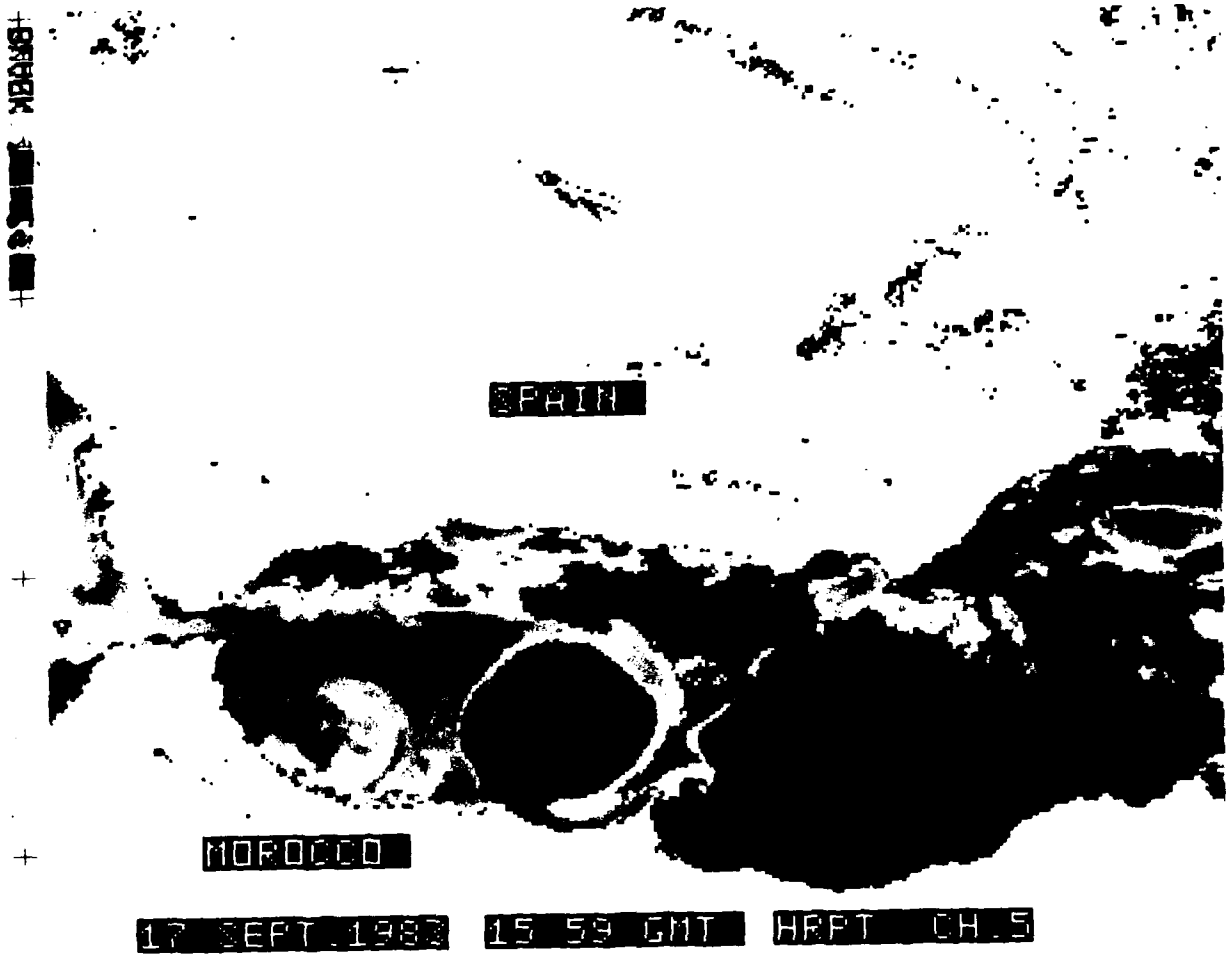


9e 17 September 1983
HRPT Channel 4, thermal infrared

Original distorted image

Methodology This is an original (unenlarged) image of the Alboran Sea. Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation. A colour scale of temperature values is given on the right.

Analysis The water circulation and thermal fronts are evident in the western part and in the eastern part of the Strait of Gibraltar.



9f 17 September 1983
HRPT Channel 5, thermal infrared

Original distorted image

Methodology ---

Analysis The water circulation and thermal fronts are evident.

Fig. 10

2 OCTOBER 1983

HRPT Data

Orbit 11734 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d*
e*
f*

Mercator-transformed Images

g Channel 1 visible/near-infrared
h Channel 2 near-infrared
i Channel 4 thermal infrared
j Channel 5 thermal infrared

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

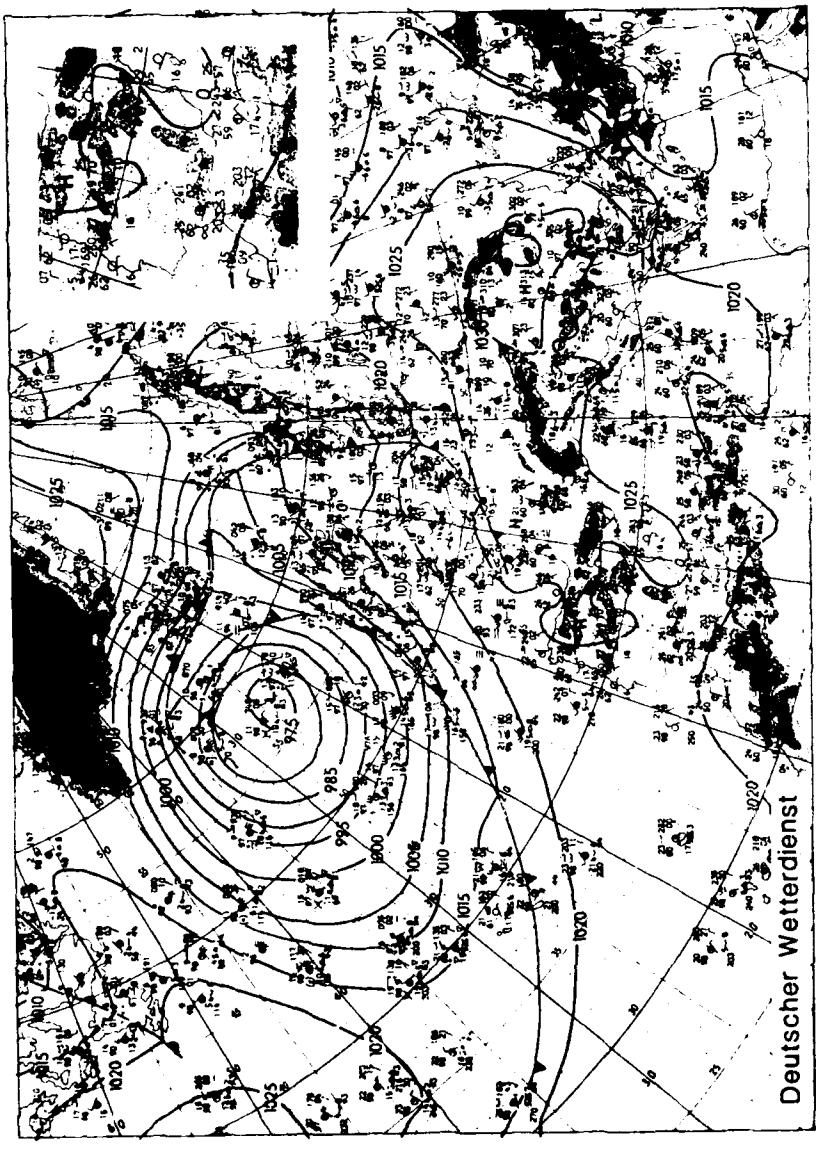


FIG. 10a 2 OCTOBER 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

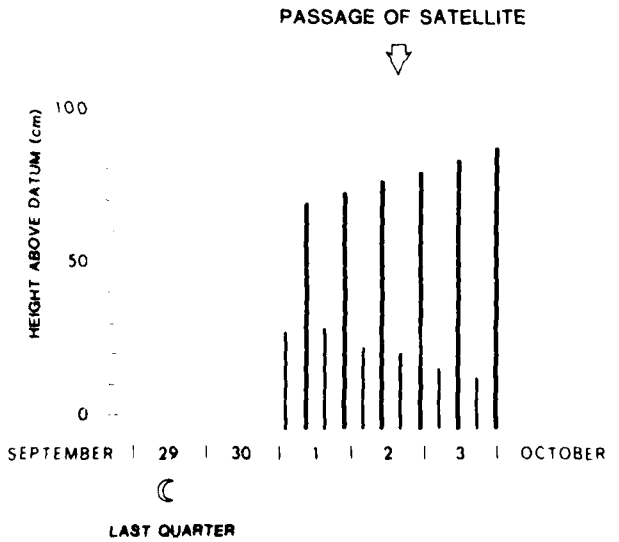
GIBRALTAR (1200Z)

WIND	: E 15 kn
CLOUD	: Cumulus and Stratocumulus
COVERAGE	: 5/8
VISIBILITY	: 12 km
TEMPERATURE	: 25°C
DEW POINT	: 20°C
RELATIVE HUMIDITY	: 74%

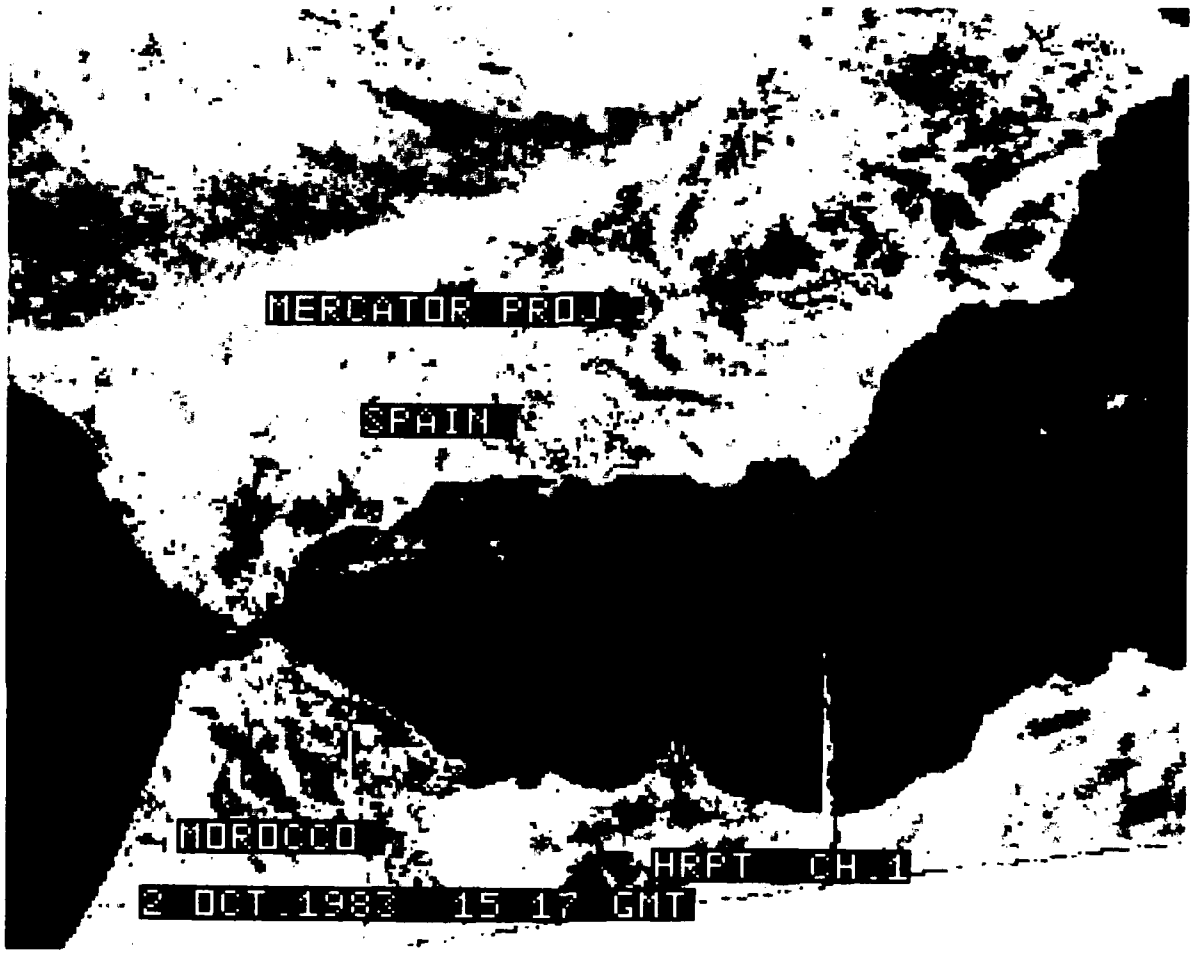
ORAN (1200Z)

WIND	: NE 10 kn
CLOUD	: Altocumulus Translucidus or Altocumulus Opacus, Stratocumulus
COVERAGE	: 1/8
VISIBILITY	: 9 km
TEMPERATURE	: 27°C
DEW POINT	: 17°C
RELATIVE HUMIDITY	: 55%

HIGH AND LOW TIDES GIBRALTAR



10b 2 October 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

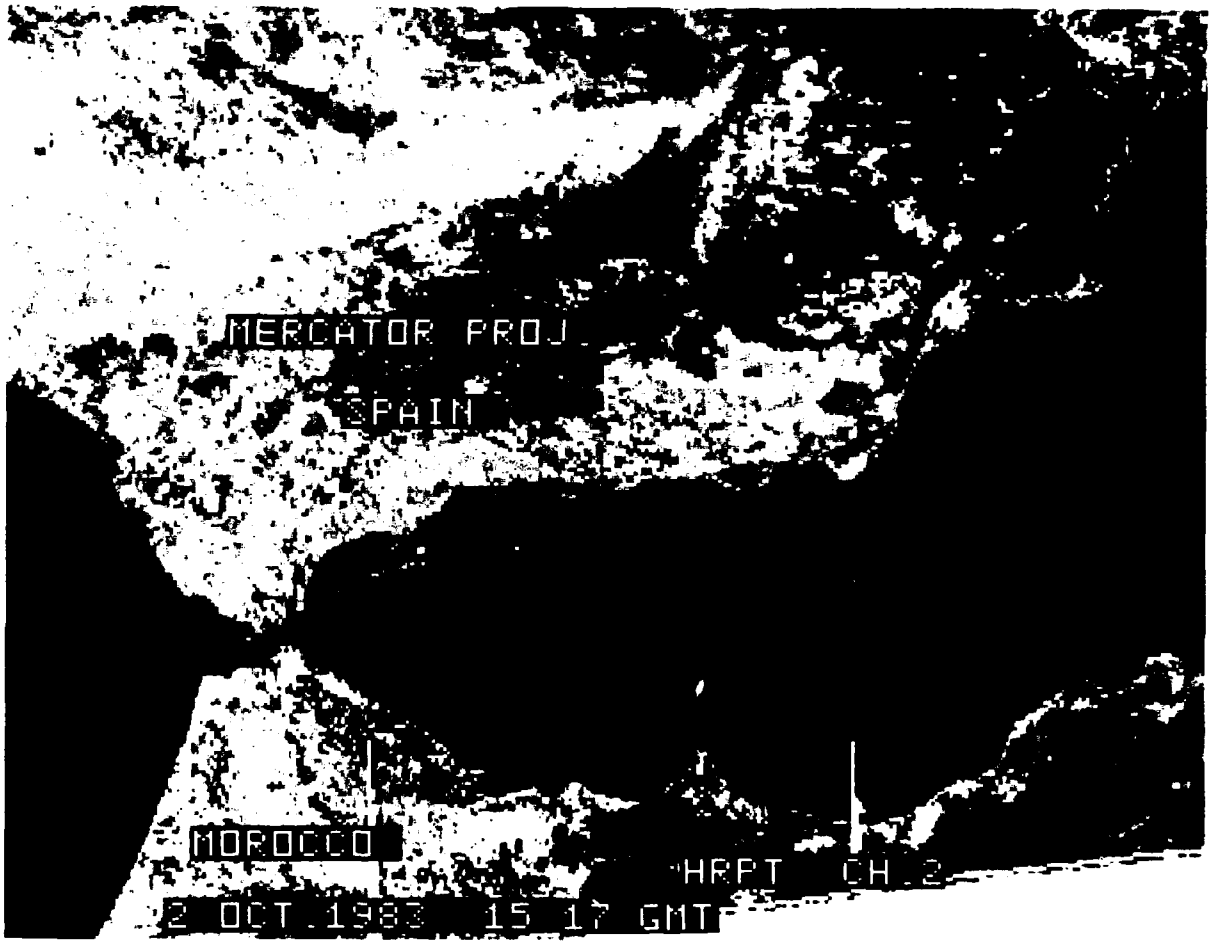


10g 2 October 1983
HRPT Channel 1, visible/near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used for daytime mapping of clouds and earth surface features.
The two white long triangles at the base of the image are caused by the stretching in the transformation process.

Analysis There are clouds along the Moroccan coast from Punta Almina towards the south-east, with small clouds near C. Tres Forcas (Moroccan coast) and over Gibraltar, extending along the Spanish coast towards the east.

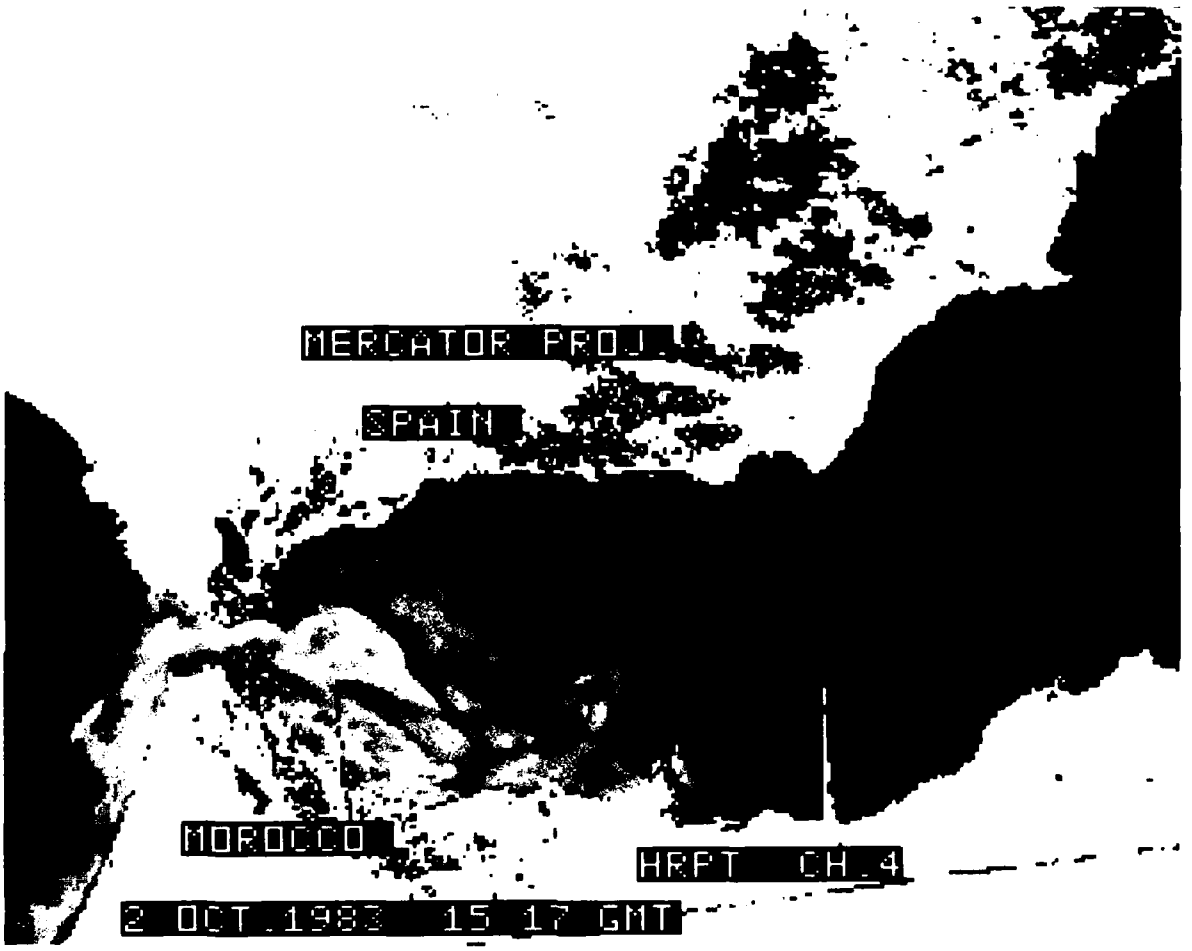


10h 2 October 1983
HRPT Channel 2, near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used to identify coastal points for use in the transformation process.
The two white long triangles of the base of the image are caused by the stretching in the transformation process.

Analysis There are clouds along the Moroccan coast from Punta Almina towards the south-east, with small clouds near C. Tres Forcas (Moroccan coast) and over Gibraltar, extending along the Spanish coast towards the east.

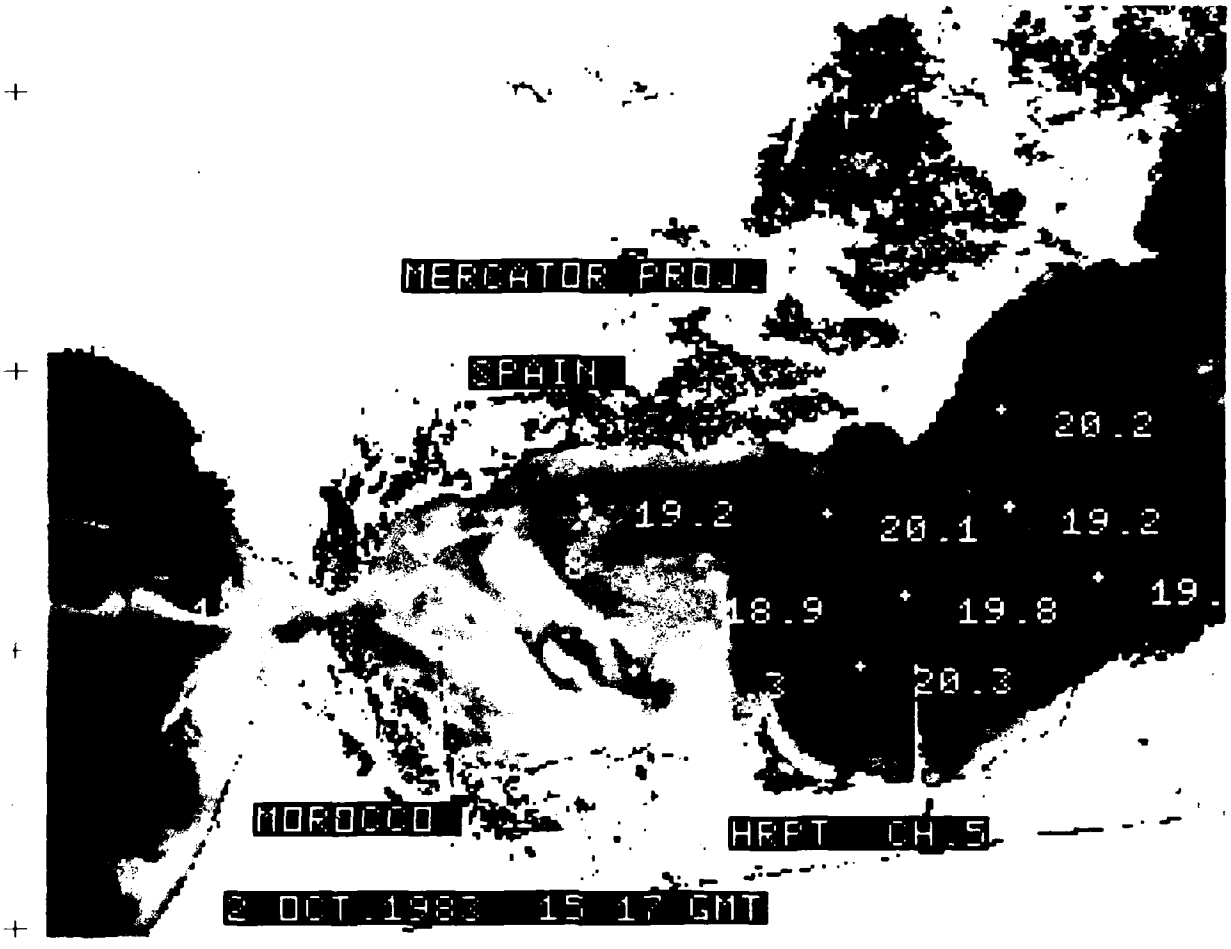


10i 2 October 1983
HRPT Channel 4, thermal infrared

Transformed to Mercator projection (north at top)

Methodology The two white long triangles at the base of the image are caused by the stretching in the transformation process.

Analysis The water circulation along the Moroccan coast from Punta Almina towards the south-east is falsified by cloud.

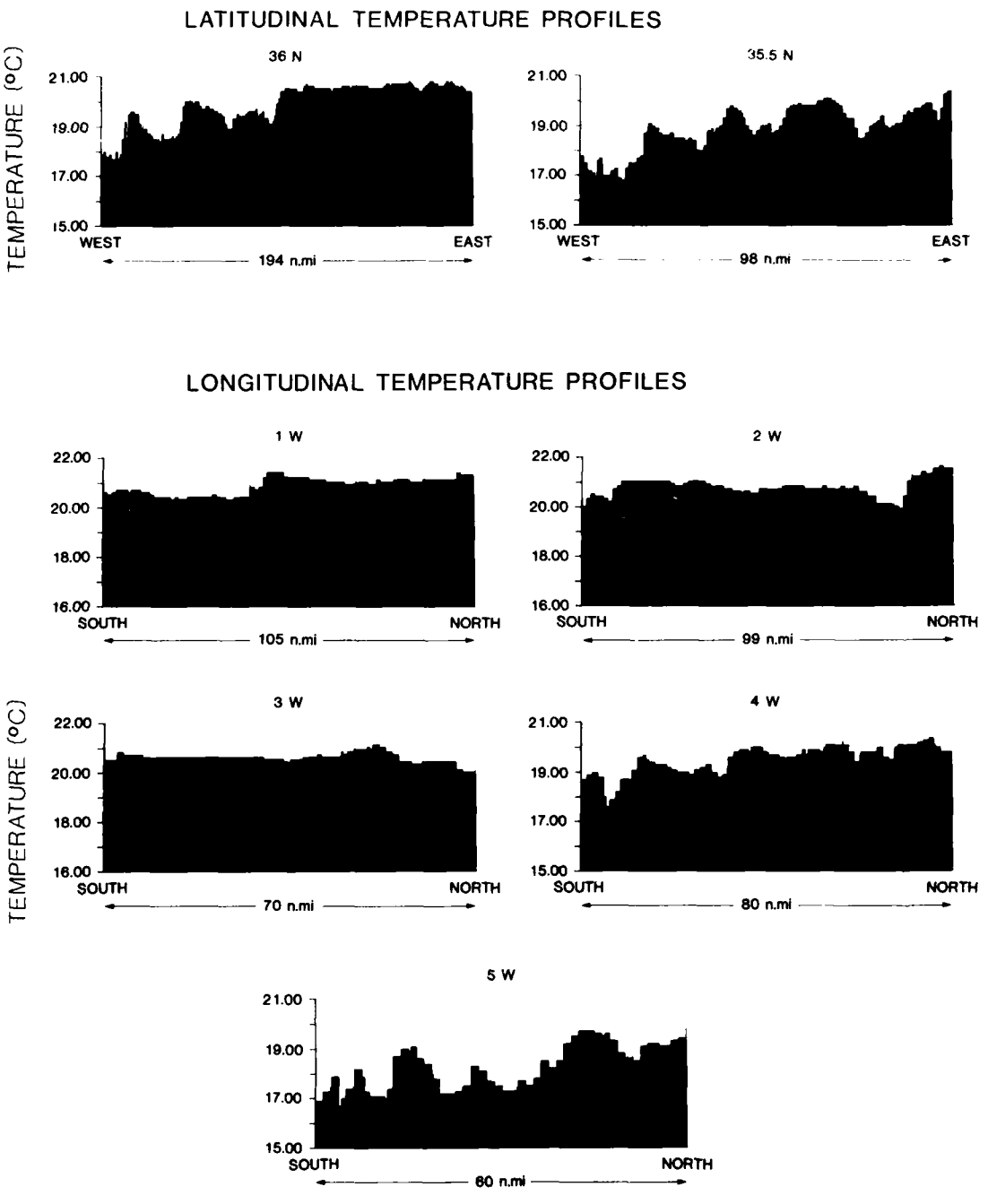


10j 2 October 1983
HRPT Channel 5, thermal infrared

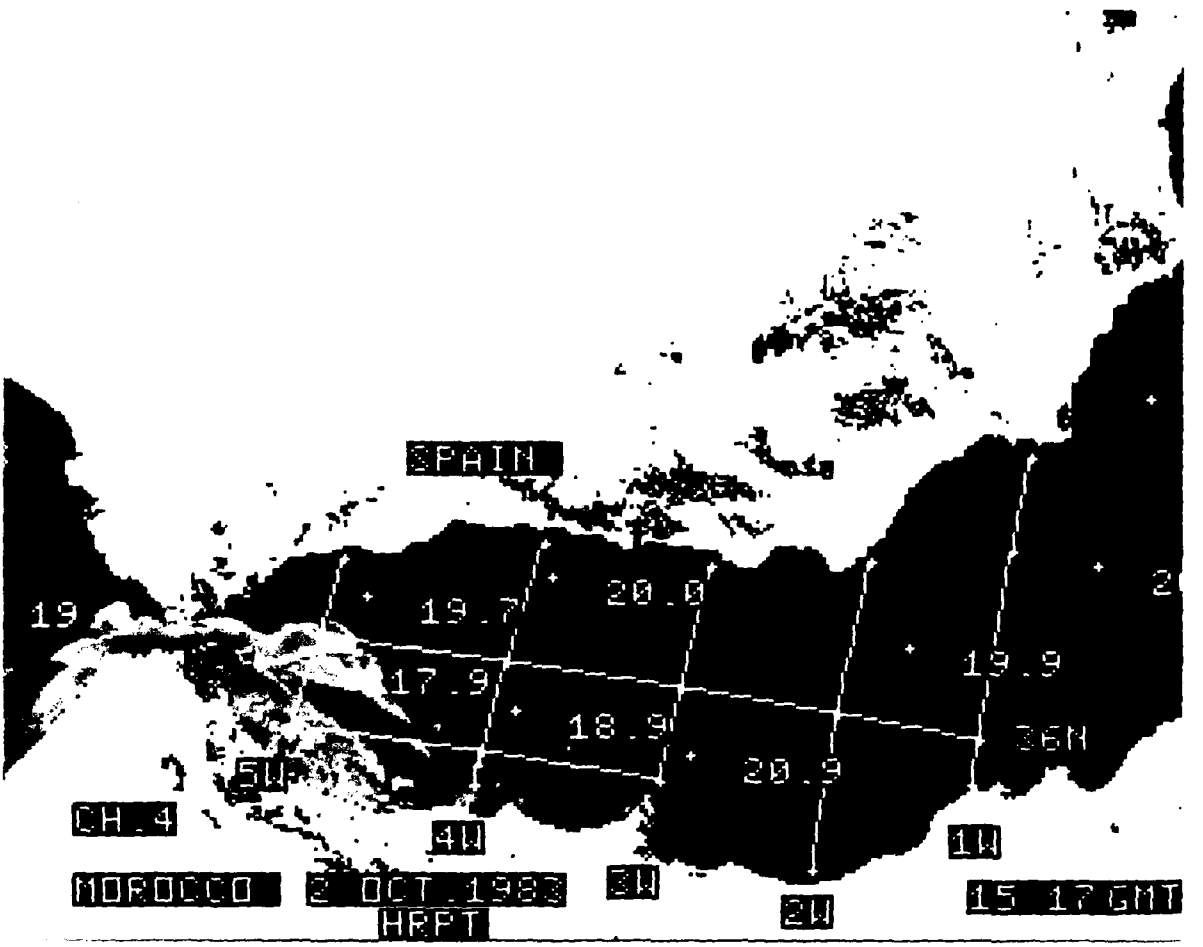
Transformed to Mercator projection (north at top)

Methodology Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.
The two white long triangles at the base of the image are caused by the stretching in the transformation process.

Analysis The water circulation along the Moroccan coast from Punta Almina towards the south-east is falsified by cloud.



10k 2 October 1983
Temperature profiles along tracks shown in Fig. 10m
(not corrected for atmospheric attenuation)



10m 2 October 1983
HRPT Channel 4, thermal infrared

Original distorted image showing tracks of temperature profiles presented in Fig. 10k

Methodology Some temperatures of the different water masses are plotted. They are not corrected for atmospheric attenuation.

Analysis The water circulation along the Moroccan coast from Punta Almina towards the south-east is falsified by cloud.

Fig. 11

10 OCTOBER 1983

HRPT Data

Orbit 11847 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d*
e*
f Channel 5 thermal infrared

Mercator-transformed Images

g Channel 1 visible/near-infrared
h Channel 2 near-infrared
i Channel 4 thermal infrared
j*

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

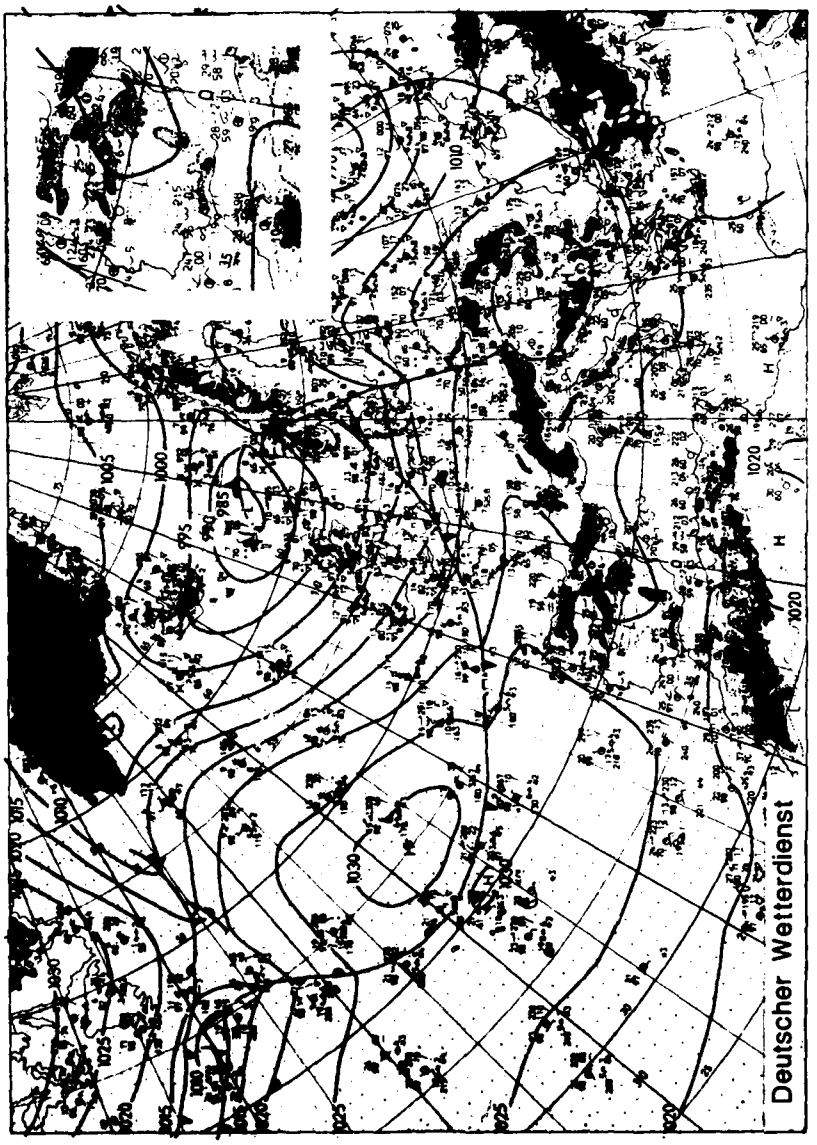


FIG. 11a 10 OCTOBER 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

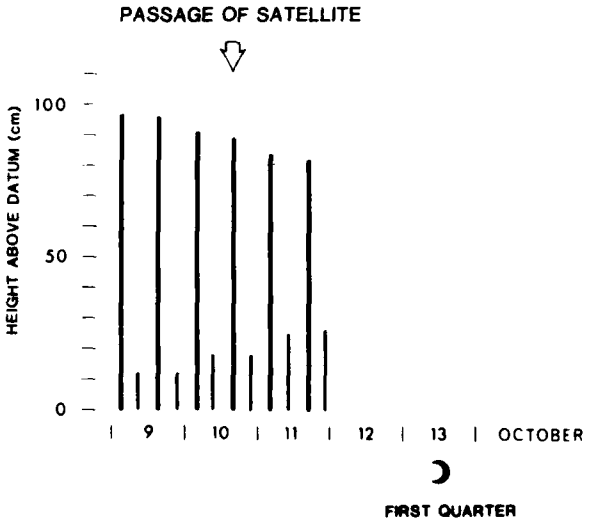
GIBRALTAR (1200Z)

WIND	: S 10 kn
CLOUD	: Altocumulus Translucidus
COVERAGE	: 1/8
VISIBILITY	: 6 km
TEMPERATURE	: 24°C
DEW POINT	: 19°C
RELATIVE HUMIDITY	: 74%

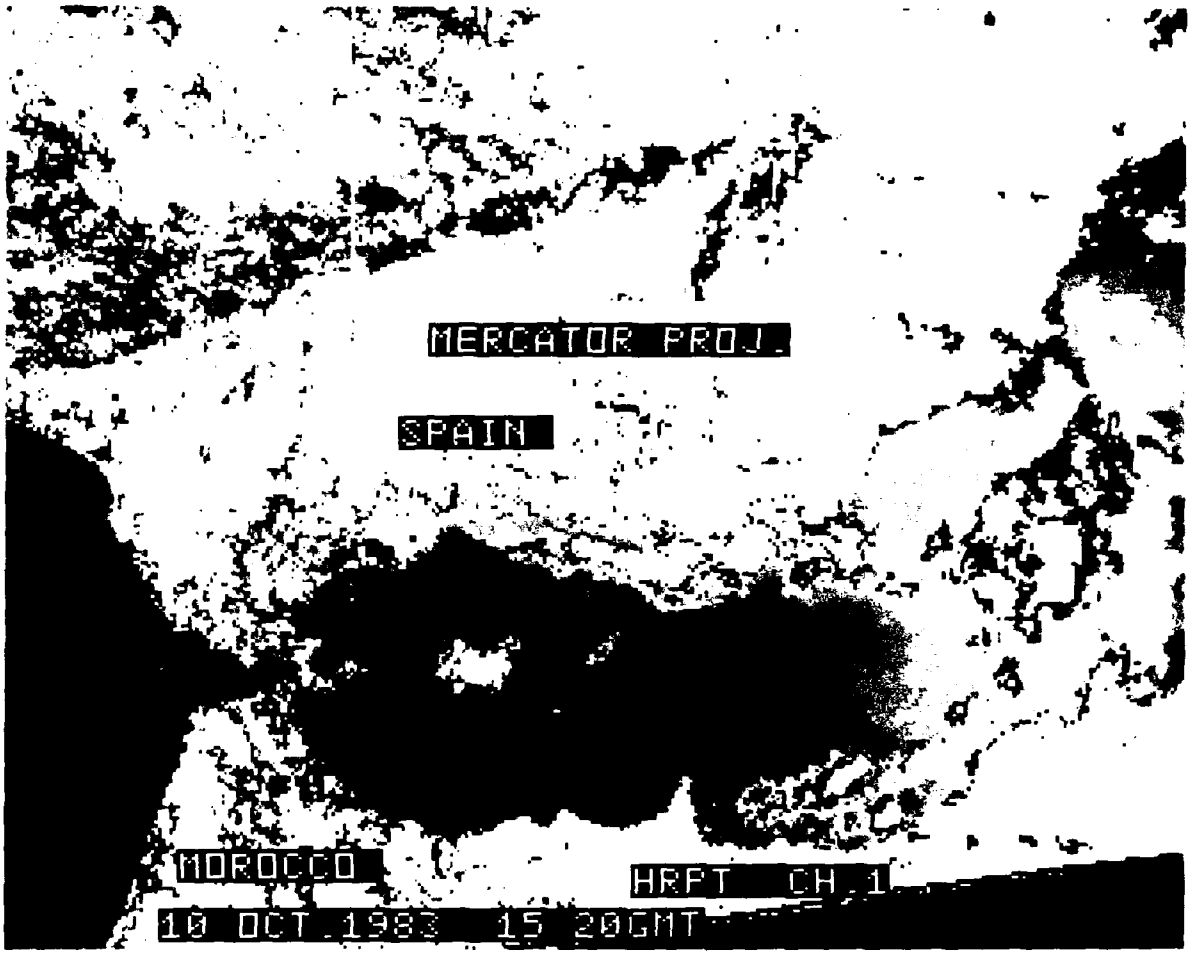
ORAN (1200Z)

WIND	: N 10 kn
CLOUD	: Altocumulus Translucidus or Altocumulus Opacus
COVERAGE	: 5/8
VISIBILITY	: 9 km
TEMPERATURE	: 28°C
DEW POINT	: 19°C
RELATIVE HUMIDITY	: 58%

HIGH AND LOW TIDES GIBRALTAR



11b 10 October 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

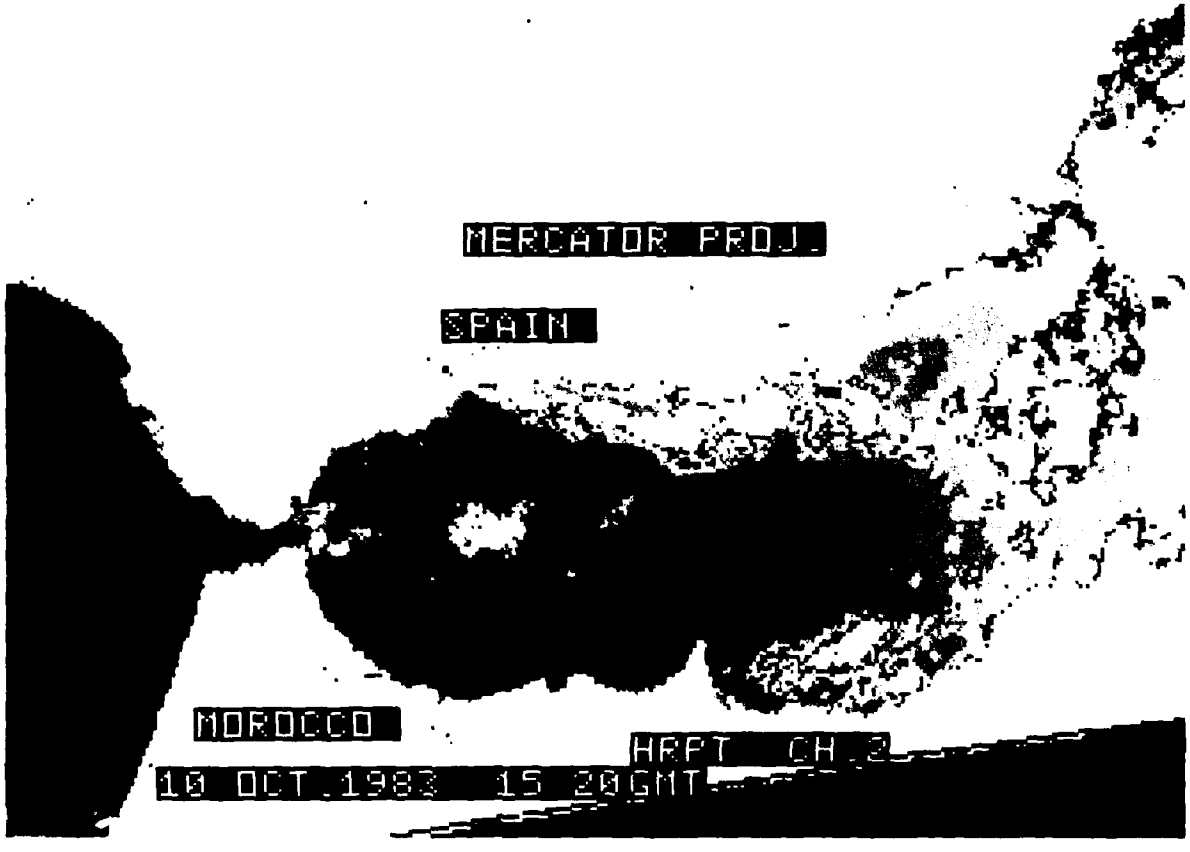


11g 10 October 1983
HRPT Channel 1, visible/near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis There are clouds over Gibraltar and east of the strait, along the Spanish coast, and in the eastern part of the Alboran Sea.

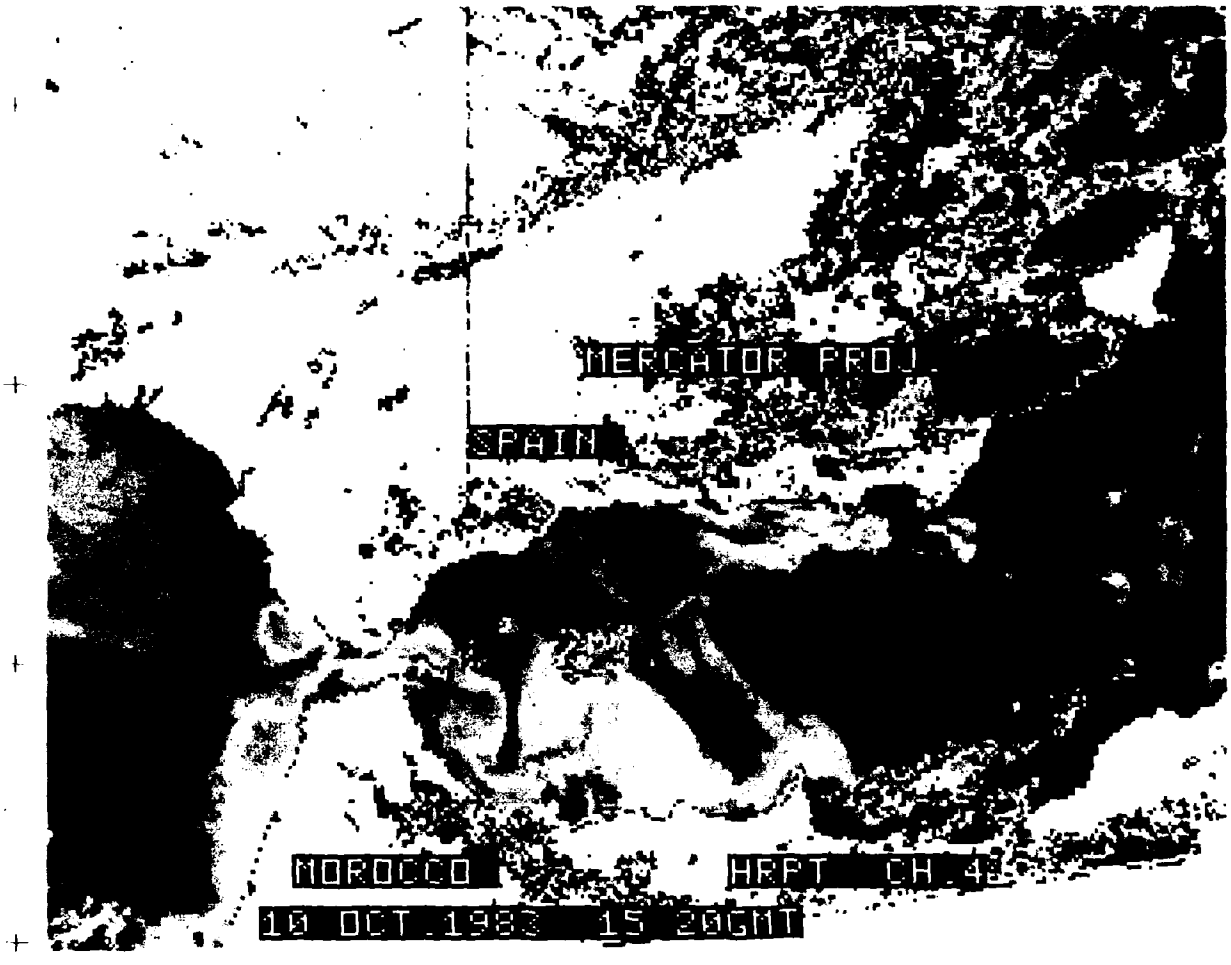


11h 10 October 1983
HRPT Channel 2, near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used to identify coastal points for use in the transformation process.

Analysis There are clouds over Gibraltar and east of the strait, along the Spanish coast, and in the eastern part of the Alboran sea.



11i 10 October 1983
HRPT Channel 4, thermal infrared

Transformed to Mercator projection (north at top)

Methodology ---

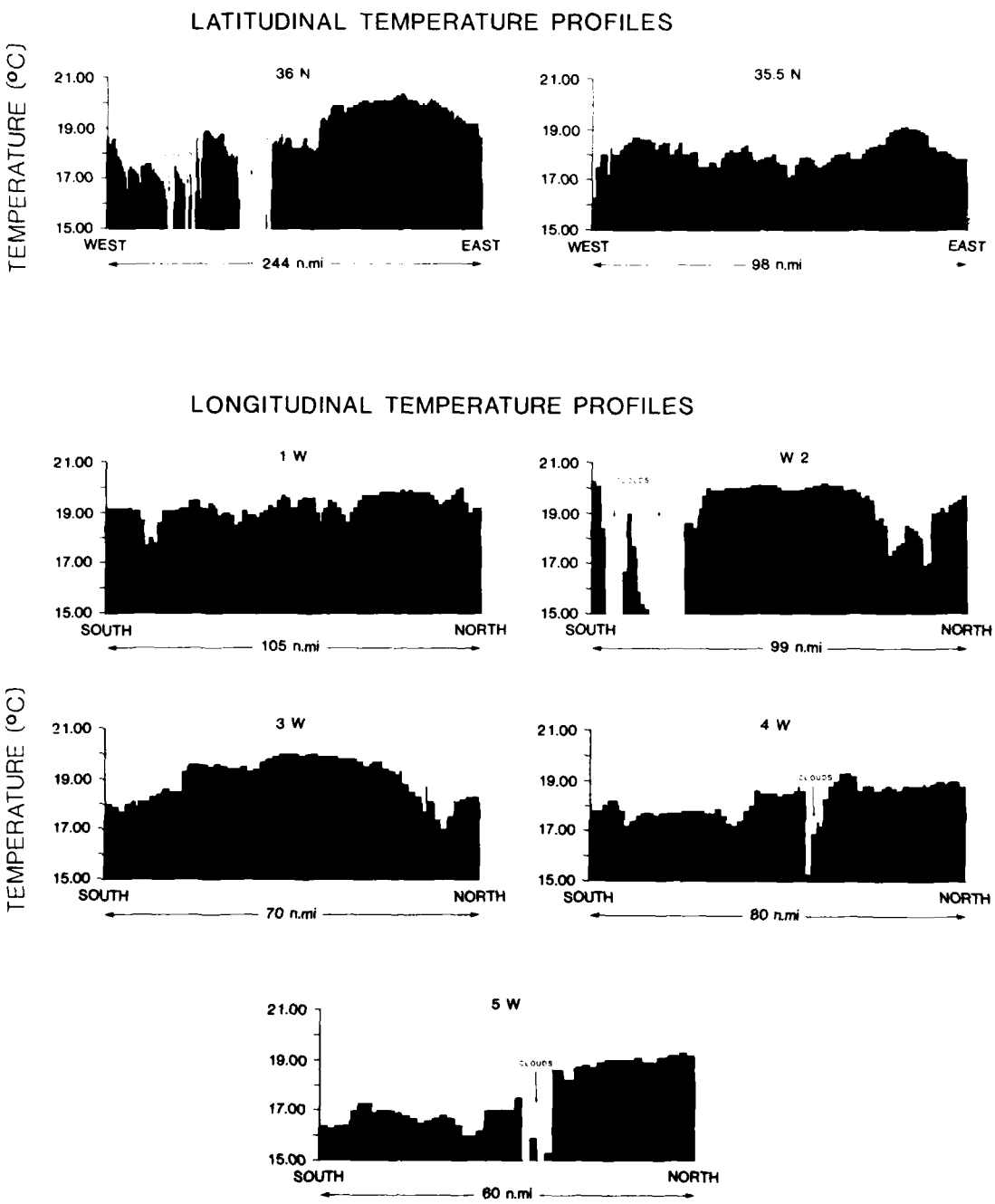
Analysis The water circulation along the Spanish coast and in the eastern part of the Alboran Sea is partly falsified by cloud. Cloud is evident elsewhere.

11j 10 October 1983
HRPT Channel 5, thermal infrared

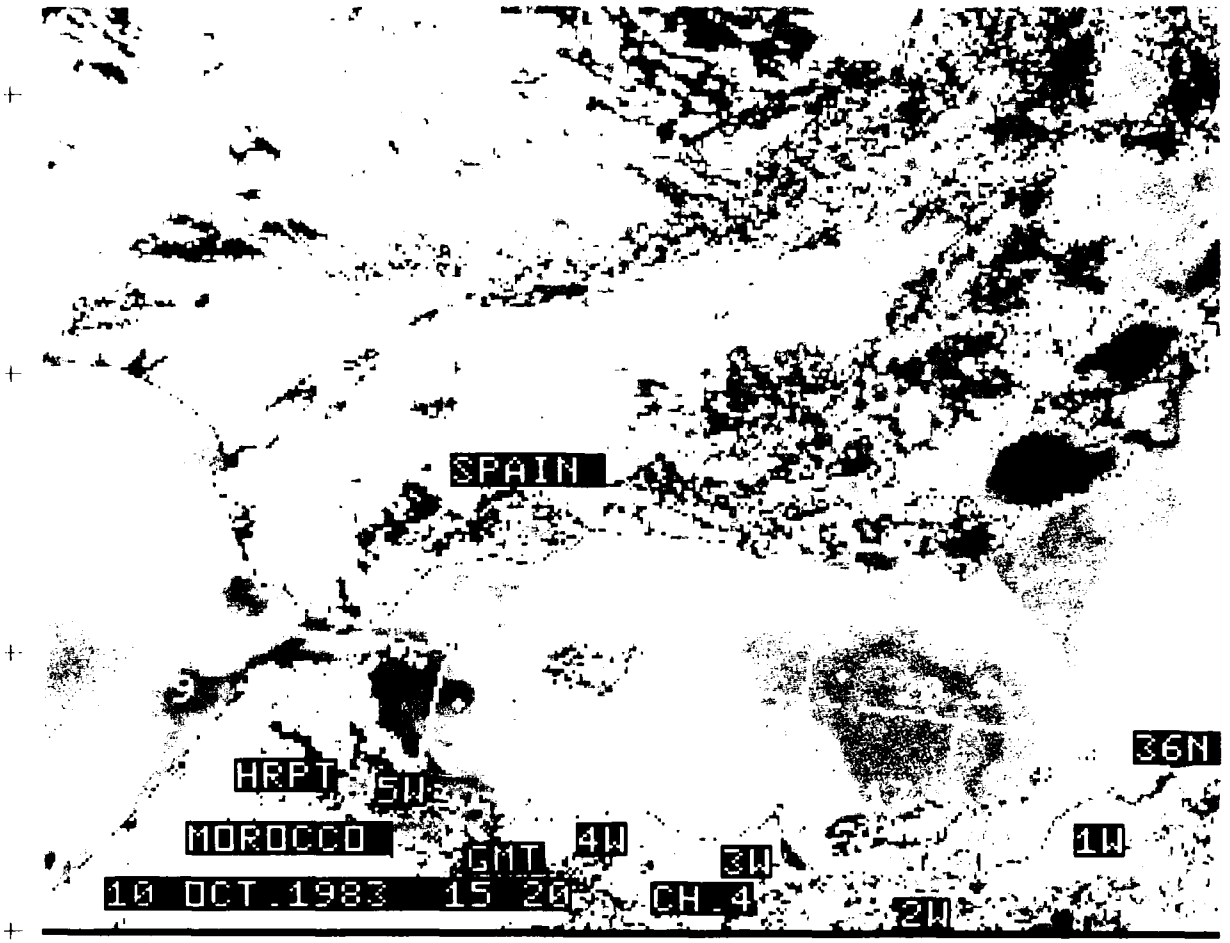
Original distorted image

Methodology This is an original (unenlarged) image of the Alboran Sea. Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation. A colour scale of temperature values is given on the right.

Analysis The water circulation along the Spanish coast and in the eastern part of the Alboran Sea is partly falsified by cloud. Cloud is evident elsewhere.



11k 10 October 1983
Temperature profiles along tracks shown in Fig. 11m
(not corrected for atmospheric attenuation)



11m 10 October 1983
HRPT Channel 4, thermal infrared

Original distorted image showing tracks of temperature profiles presented in Fig. 11k

Methodology Some temperatures of the different water masses are plotted. They are not corrected for atmospheric attenuation.

Analysis The water circulation along the Spanish coast and in the eastern part of the Alboran Sea is partly falsified by cloud. Cloud is evident elsewhere.

Fig. 12

19 OCTOBER 1983

HRPT Data

Orbit 11974 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c*
d*
e*
f*

Mercator-transformed Images

g Channel 1 visible/near-infrared
h Channel 2 near-infrared
i Channel 4 thermal infrared
j Channel 5 thermal infrared

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

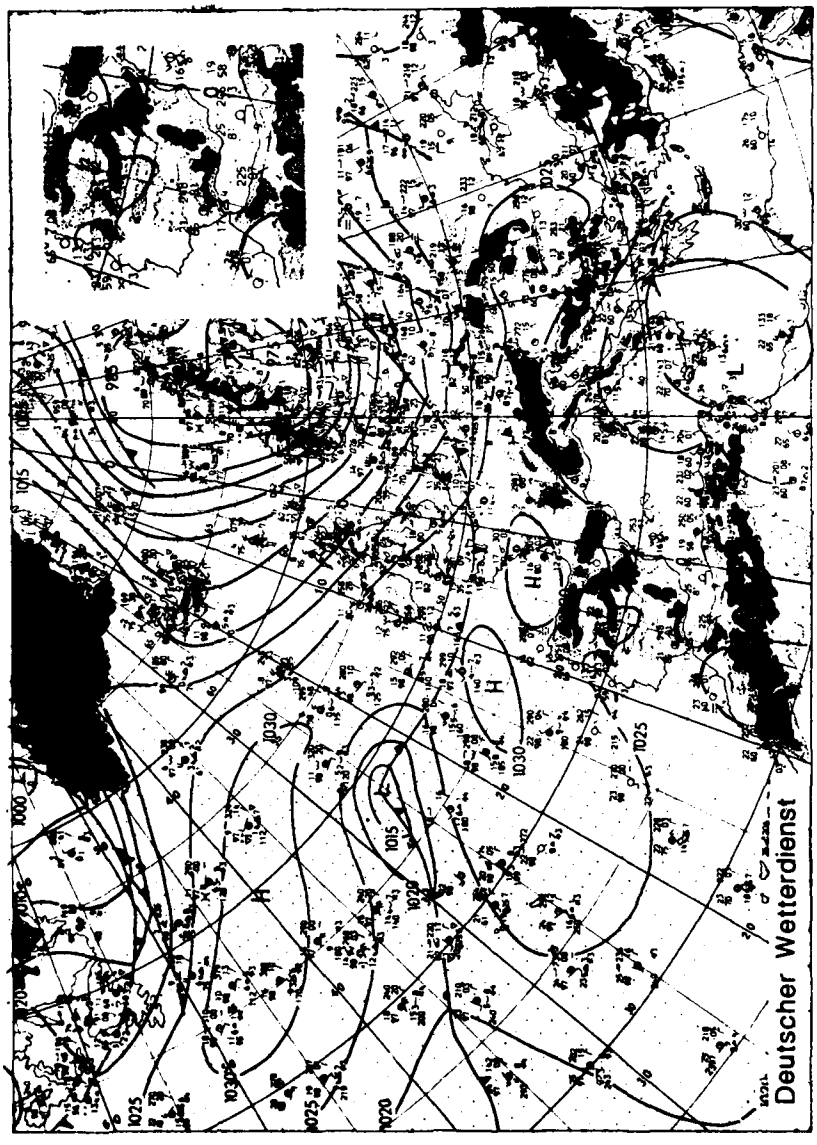


FIG. 12a 19 OCTOBER 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

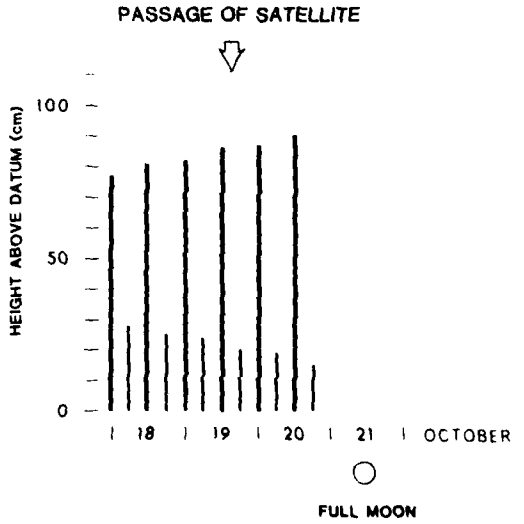
GIBRALTAR (1200Z)

WIND	: E 20 kn
CLOUD	: Cumulus and Stratocumulus
COVERAGE	: 4/8
VISIBILITY	: 15 km
TEMPERATURE	: 21°C
DEW POINT	: 17°C
RELATIVE HUMIDITY	: 78%

ORAN (1200Z)

WIND	: E 10 kn
CLOUD	: ---
COVERAGE	: ---
VISIBILITY	: 35 km
TEMPERATURE	: 25°C
DEW POINT	: 9°C
RELATIVE HUMIDITY	: 36%

HIGH AND LOW TIDES GIBRALTAR



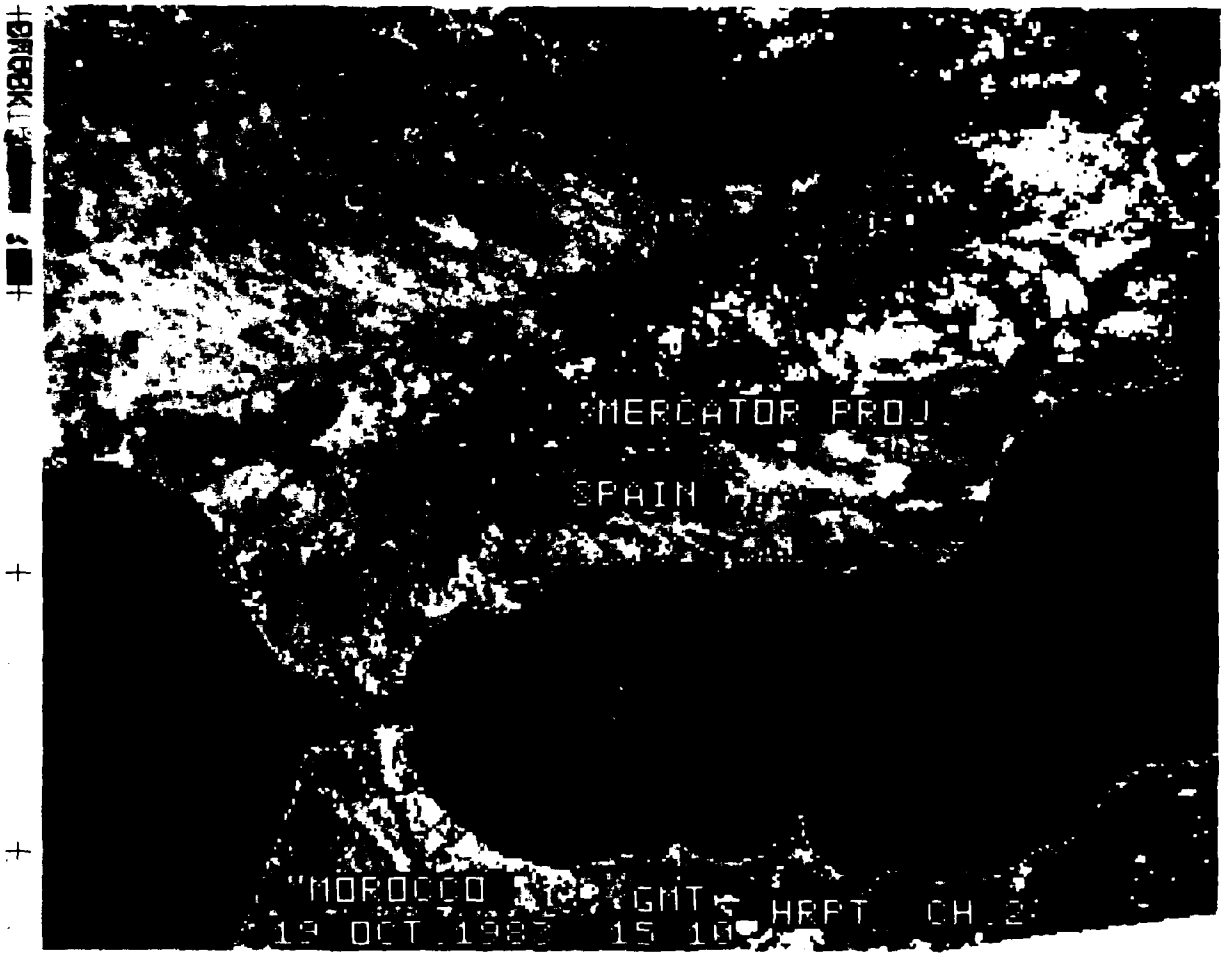
12b 19 October 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

12g 19 October 1983
HRPT Channel 1, visible/near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis There are small clouds over Gibraltar, but the Alboran Sea is free of clouds.

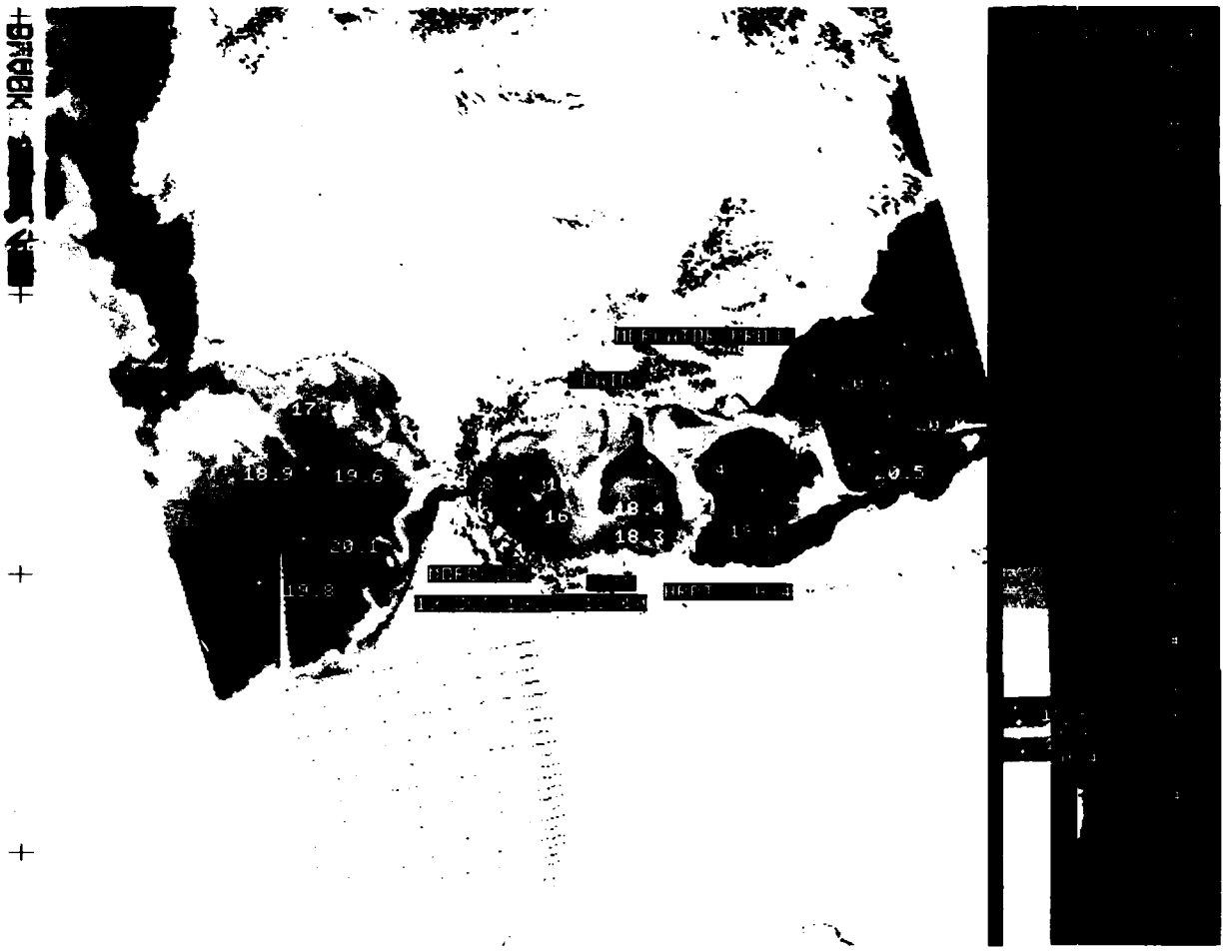


12h 10 October 1983
HRPT Channel 2, near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used to identify coastal points for use in the transformation process.

Analysis There are small clouds over Gibraltar, but the Alboran Sea is free of clouds.



12i 19 October 1983
HRPT Channel 4, thermal infrared

Transformed to Mercator Projection (north at top)

Methodology This is an original (unenlarged) image of the Alboran Sea. Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation. A colour scale of temperature values is given on the right.
The white long triangle at the base of the image, in the left part, is caused by the stretching in the transformation process.

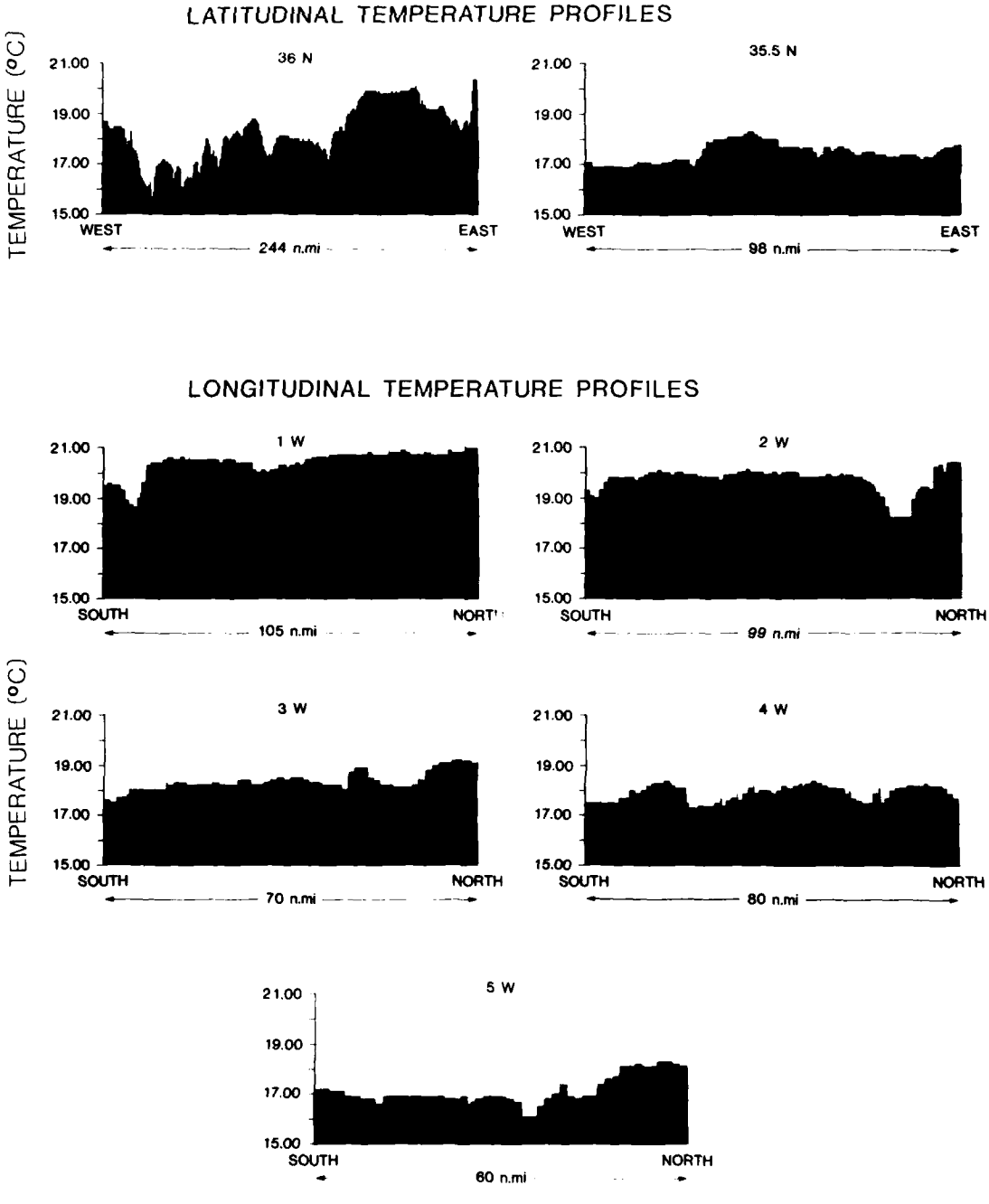
Analysis Thermal fronts are evident in the Mediterranean Sea and in the Atlantic Ocean.

12j 19 October 1983
HRPT Channel 5, thermal infrared

Transformed to Mercator projection (north at top)

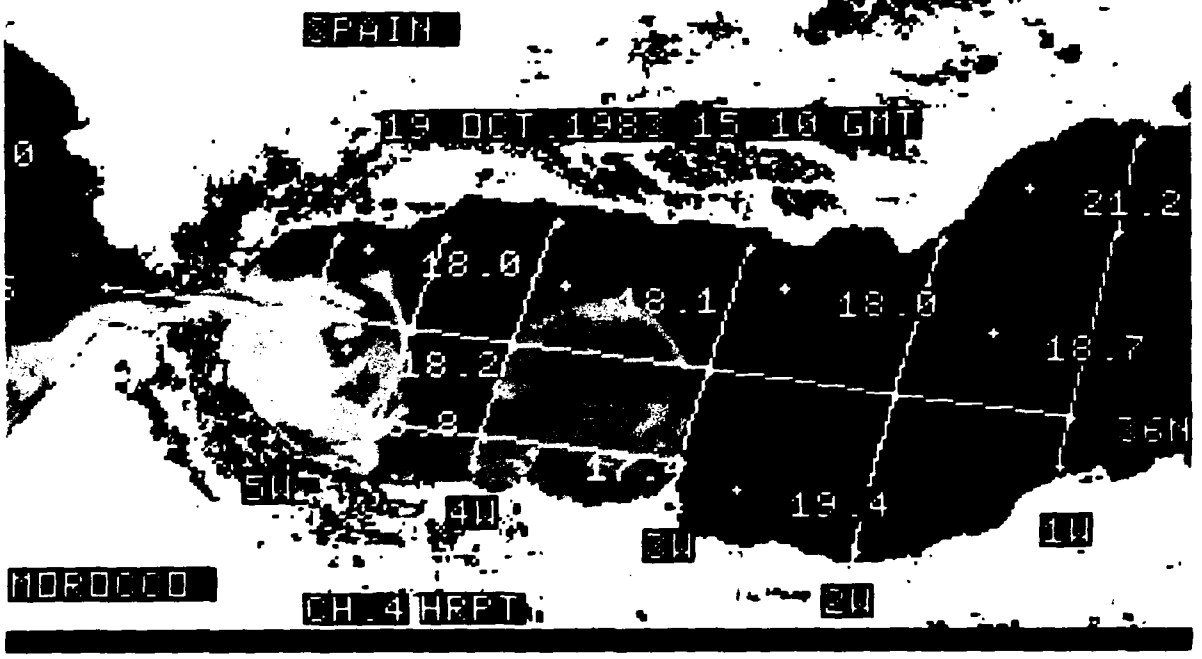
Methodology ---

Analysis Thermal fronts are evident.



12k 19 October 1983

Temperature profiles along tracks shown in Fig. 12m
(not corrected for atmospheric attenuation)



12m 19 October 1983
HRPT Channel 4, thermal infrared

Original distorted image showing tracks of temperature profiles presented in Fig. 12k

Methodology Some temperatures of the different water masses are plotted. They are not corrected for atmospheric attenuation.

Analysis Thermal fronts are evident.

Fig. 13

20 OCTOBER 1983

HRPT Data

Orbit 11988 (Dundee)

General

a Synoptic surface weather chart 1200Z
b Meteorological data and tidal forecast 1200Z

Original Distorted Images

c Channel 1 visible near-infrared
d Channel 2 near-infrared
e Channel 4 thermal infrared
f*

Mercator-transformed Images

g Channel 1 visible/near-infrared
h Channel 2 near-infrared (with nautical chart overlay)
i Channel 4 thermal infrared
j Channel 5 thermal infrared

Sea-surface Temperatures

k Temperature profiles along tracks shown on (m)
m Track of temperature profiles displayed in (k)

*Not provided.

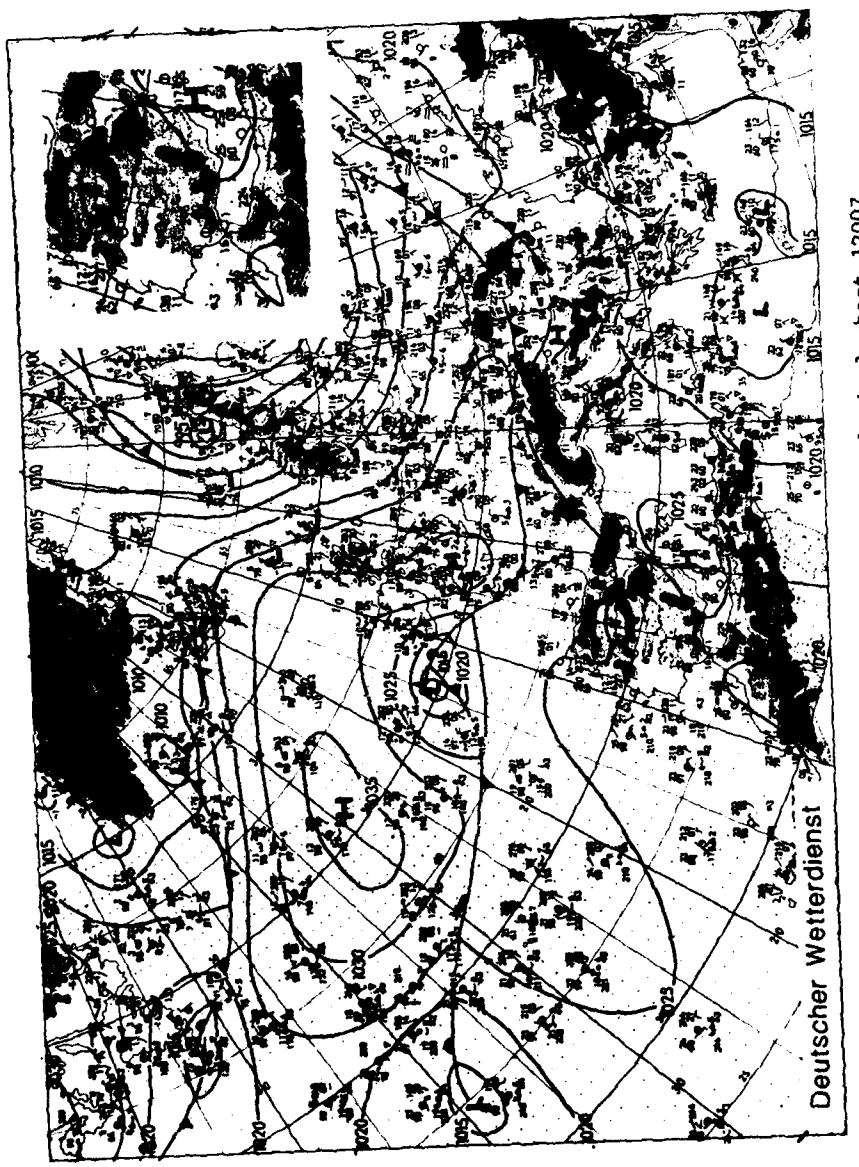


FIG. 13a 20 OCTOBER 1983. Surface synoptic meteorological chart 1200Z, with enlarged Alboran Sea details as inset.

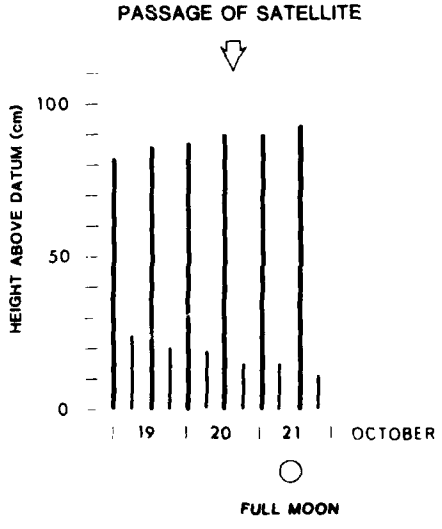
GIBRALTAR (1200Z)

WIND	: E 15 kn
CLOUD	: Stratocumulus
COVERAGE	: 1/8
VISIBILITY	: 30 km
TEMPERATURE	: 23°C
DEW POINT	: 16°C
RELATIVE HUMIDITY	: 65%

ORAN (1200Z)

WIND	: SE 10 kn
CLOUD	: ---
COVERAGE	: ---
VISIBILITY	: 30 km
TEMPERATURE	: 25°C
DEW POINT	: 7°C
RELATIVE HUMIDITY	: 32%

HIGH AND LOW TIDES GIBRALTAR



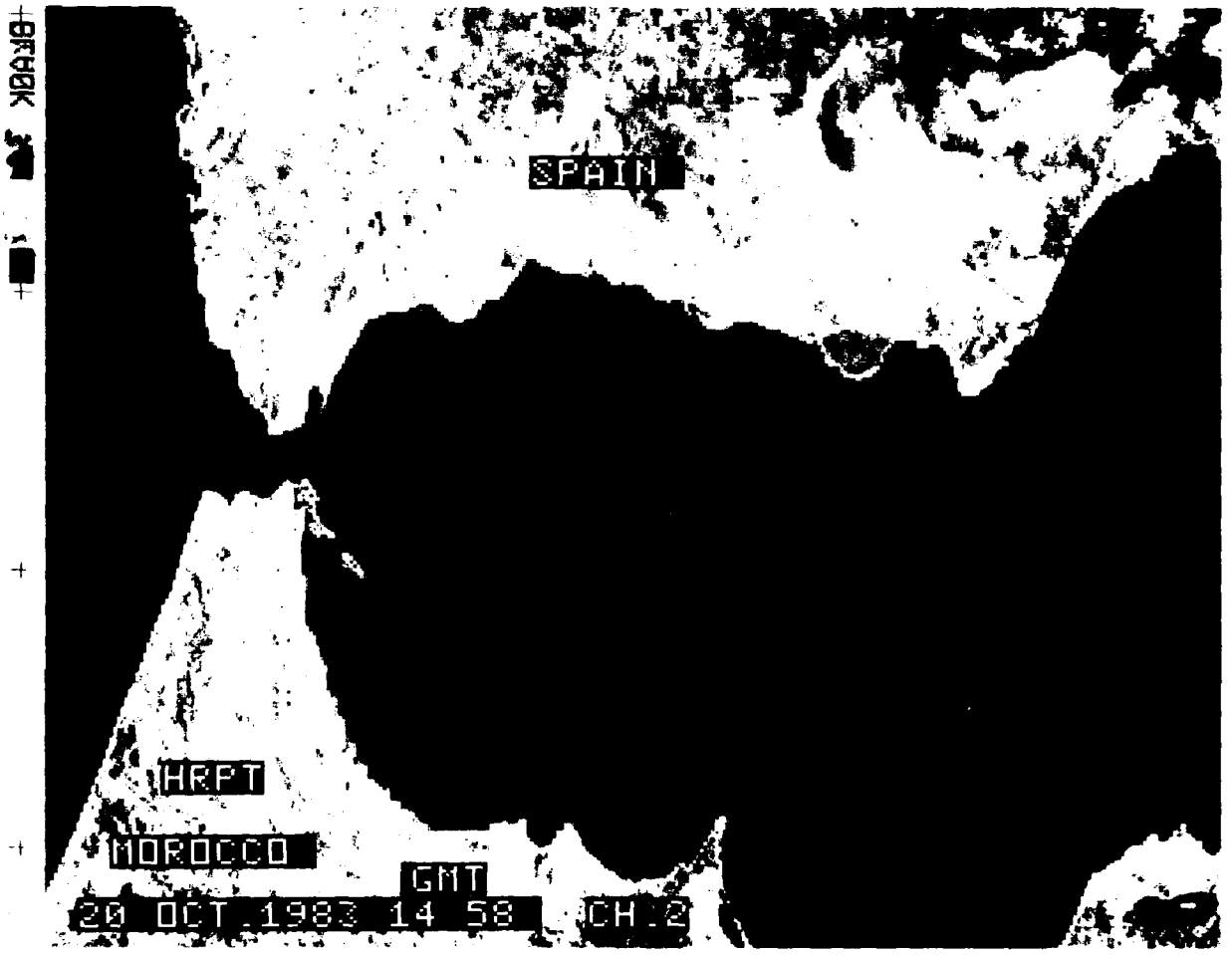
13b 20 October 1983. Meteorological data for Gibraltar and Oran. (The relative humidity was obtained from tables as a function of temperature, dew point, and atmospheric pressure.) High and low tide predictions for Gibraltar (GMT).

13c 20 October 1983
HRPT Channel 1, visible/near-infrared

Original distorted image

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis There are small clouds over Punta Almina and towards the southeast over the Alboran Sea, and also in the northern part near the Spanish coast. The rest of the Alboran Sea is free of clouds and the ground-level humidity is low. The red area westward of the Strait of Gibraltar is caused by sun glitter. The wind observed at Gibraltar is from the east at 15 kn.

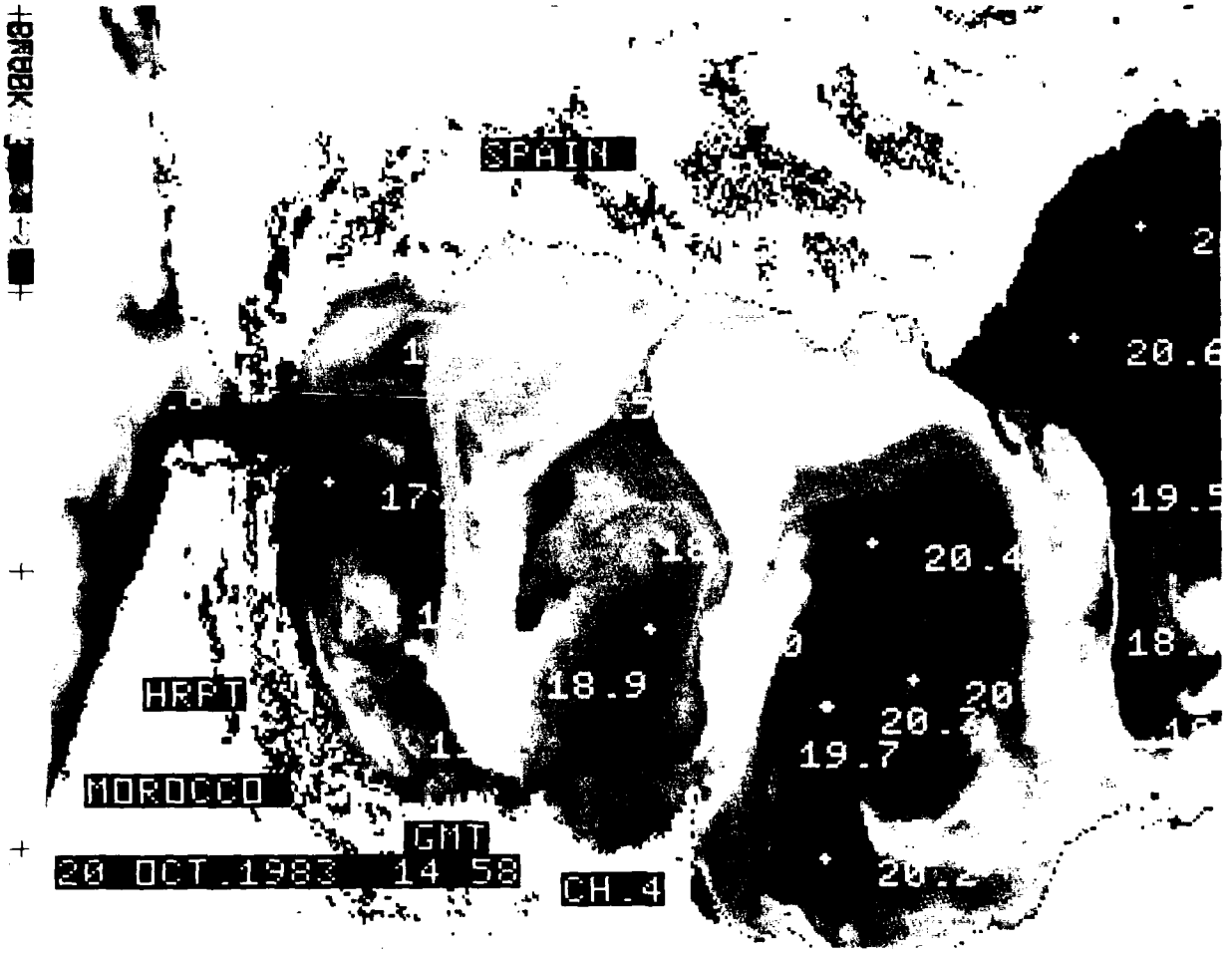


13d 20 October 1983
HRPT Channel 2, near-infrared

Original distorted image

Methodology This channel is used to identify coastal points for use in the transformation process.

Analysis The delineation of the coast is very clear. There are small clouds over Punta Almina and towards the southeast over the Alboran Sea, and also in the northern part near the Spanish coast. The rest of the Alboran Sea is free of clouds and the ground-level humidity is low. The red area westward of the Strait of Gibraltar is caused by sun glitter. The wind observed at Gibraltar is from the east at 15 kn.

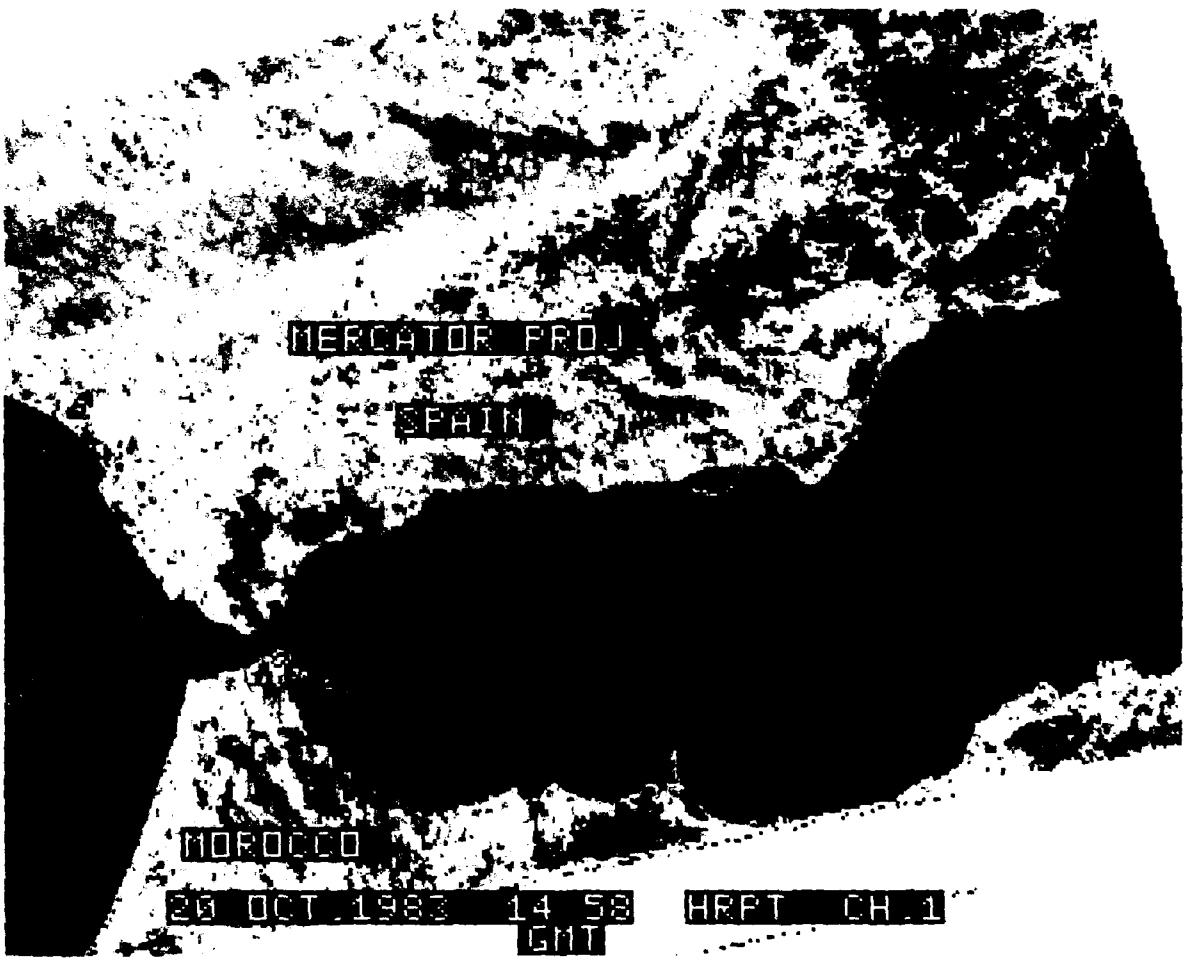


13e 20 October 1983
HRPT Channel 4, thermal infrared

Original distorted image

Methodology Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis Thermal fronts are evident.

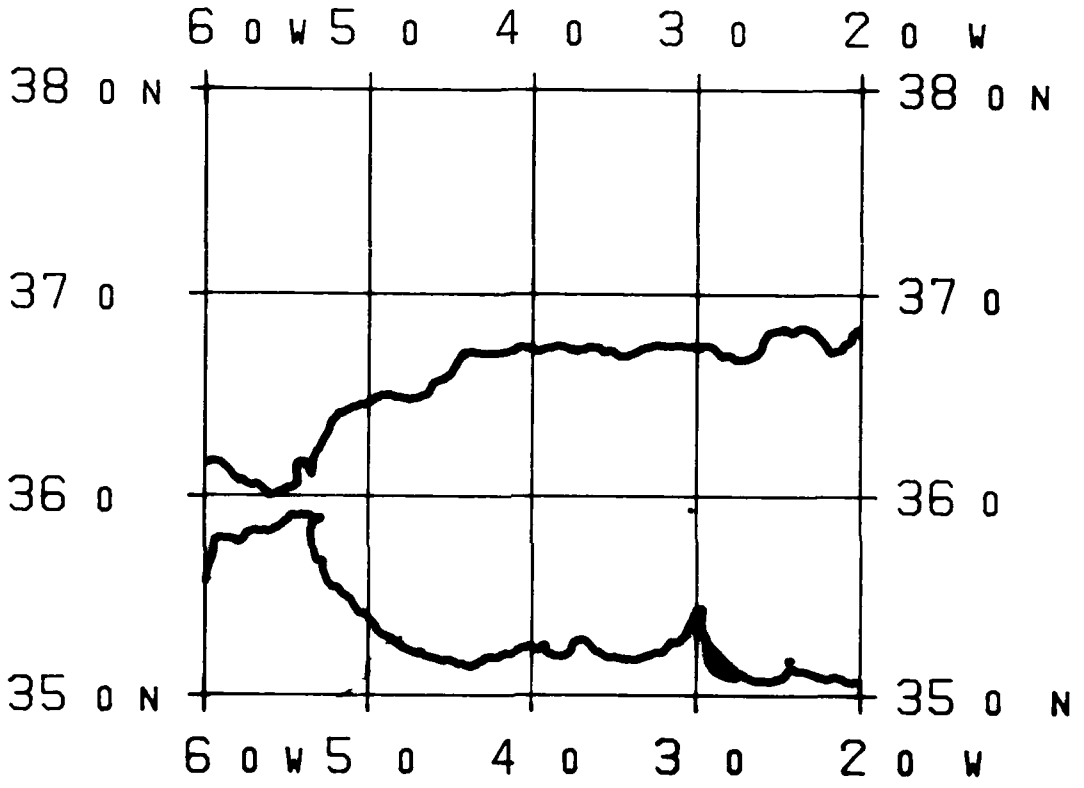


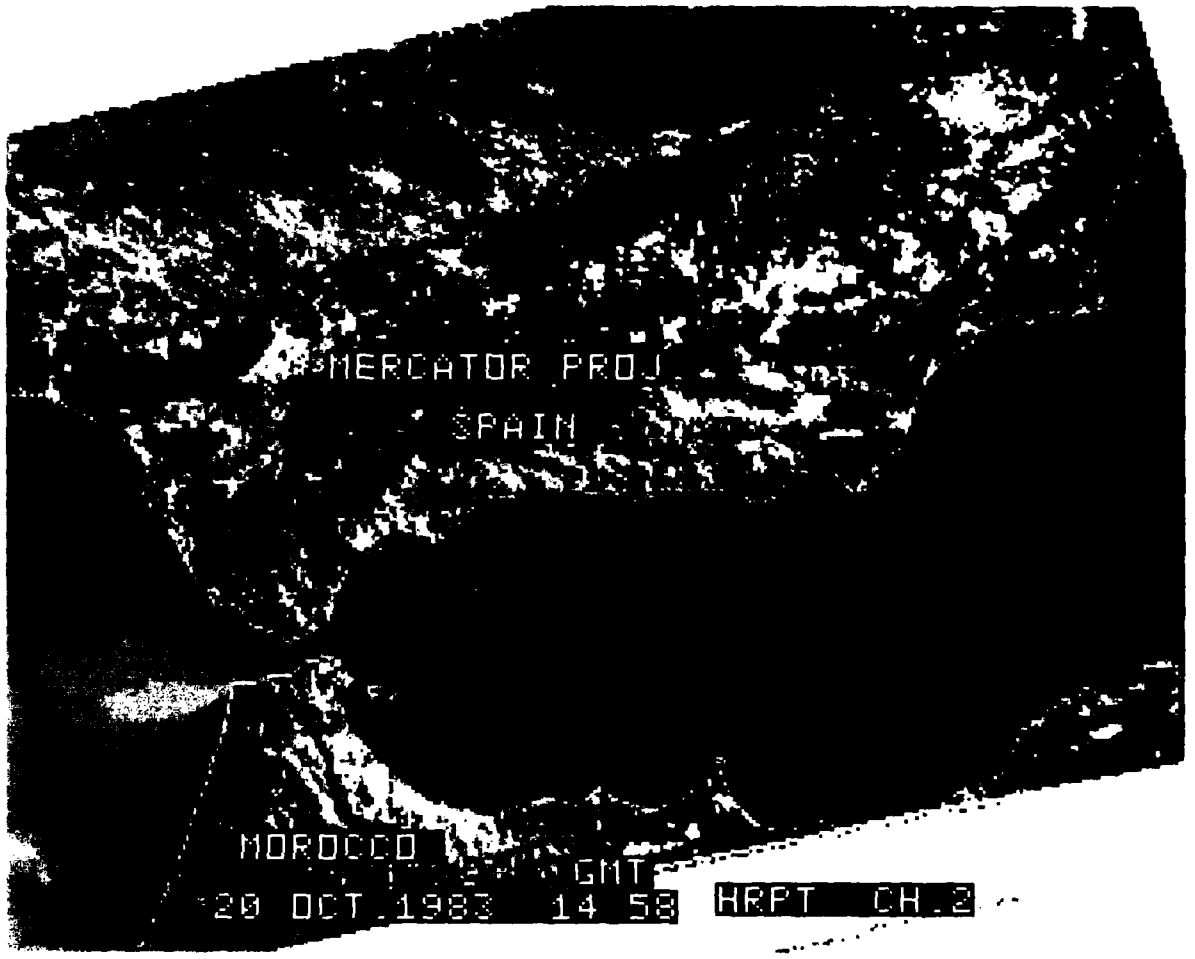
13g 20 October 1983
HRPT Channel 1, visible/near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used for daytime mapping of clouds and earth surface features.

Analysis There are small clouds over Punta Almina and towards the south-east over the Alboran Sea, and in the northern part near the Spanish coast. The rest of the Alboran Sea is free of clouds and the ground level humidity is low. The red area westward of the Strait of Gibraltar is caused by sun-glitter. The wind observed at Gibraltar is from the east at 15 kn.


60W 50 40 30 20W
38 0 N
37 0
36 0
35 0 N
38 0 N
37 0
36 0
35 0 N
60W 50 40 30 20W

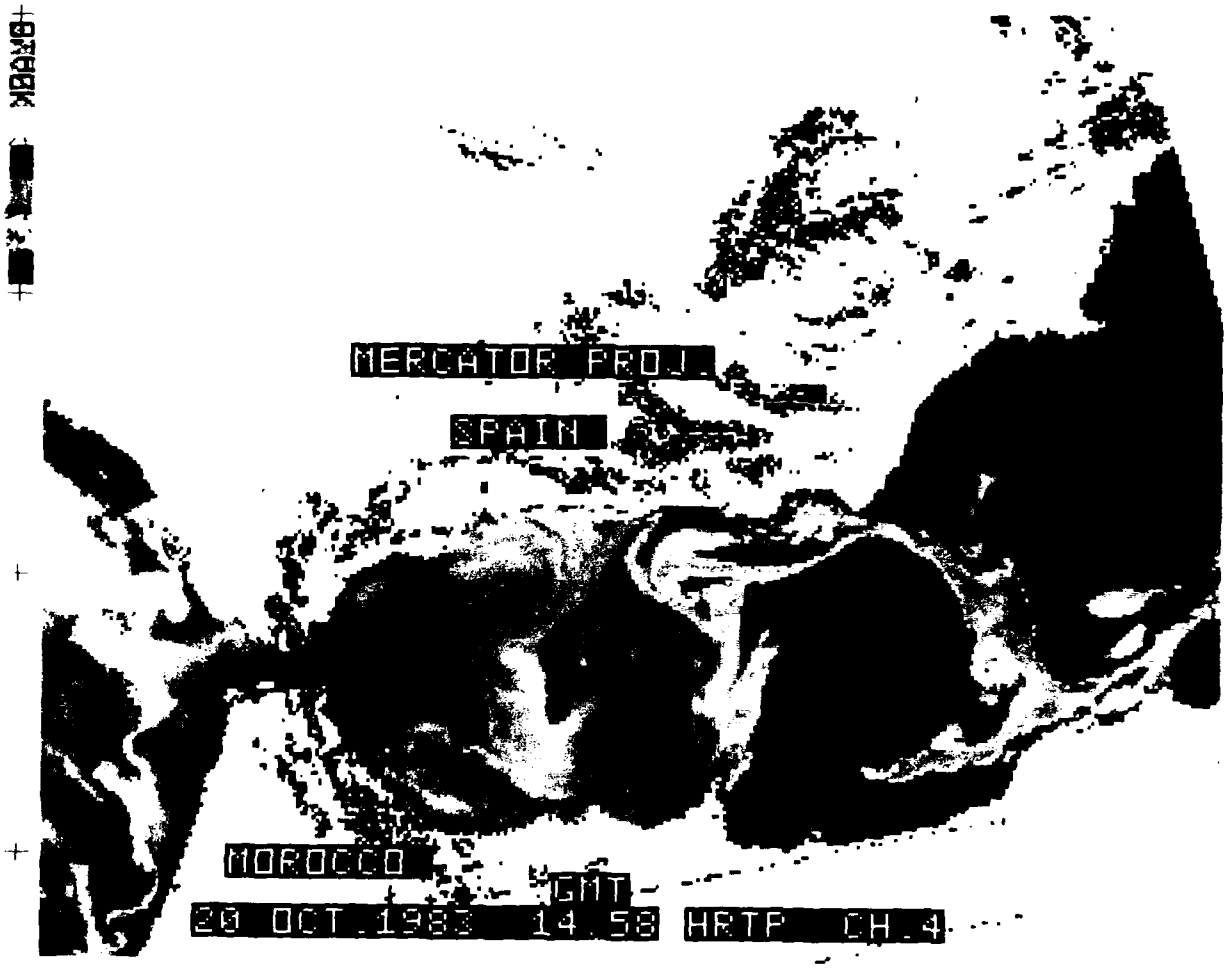


13h 20 October 1983
HRPT Channel 2, near-infrared

Transformed to Mercator projection (north at top)

Methodology This channel was used to identify coastal points for the transformation process. As an example of the accuracy of this transformation process a chart to the same scale and mid-latitude projection is provided as an overlay.

Analysis There are small clouds over Punta Almina and towards the south-east over the Alboran Sea, and in the northern part near the Spanish coast. The rest of the Alboran Sea is free of clouds and the ground level humidity is low. The red area westward of the Strait of Gibraltar is caused by sun-glitter. The wind observed at Gibraltar is from the east at 15 kn.



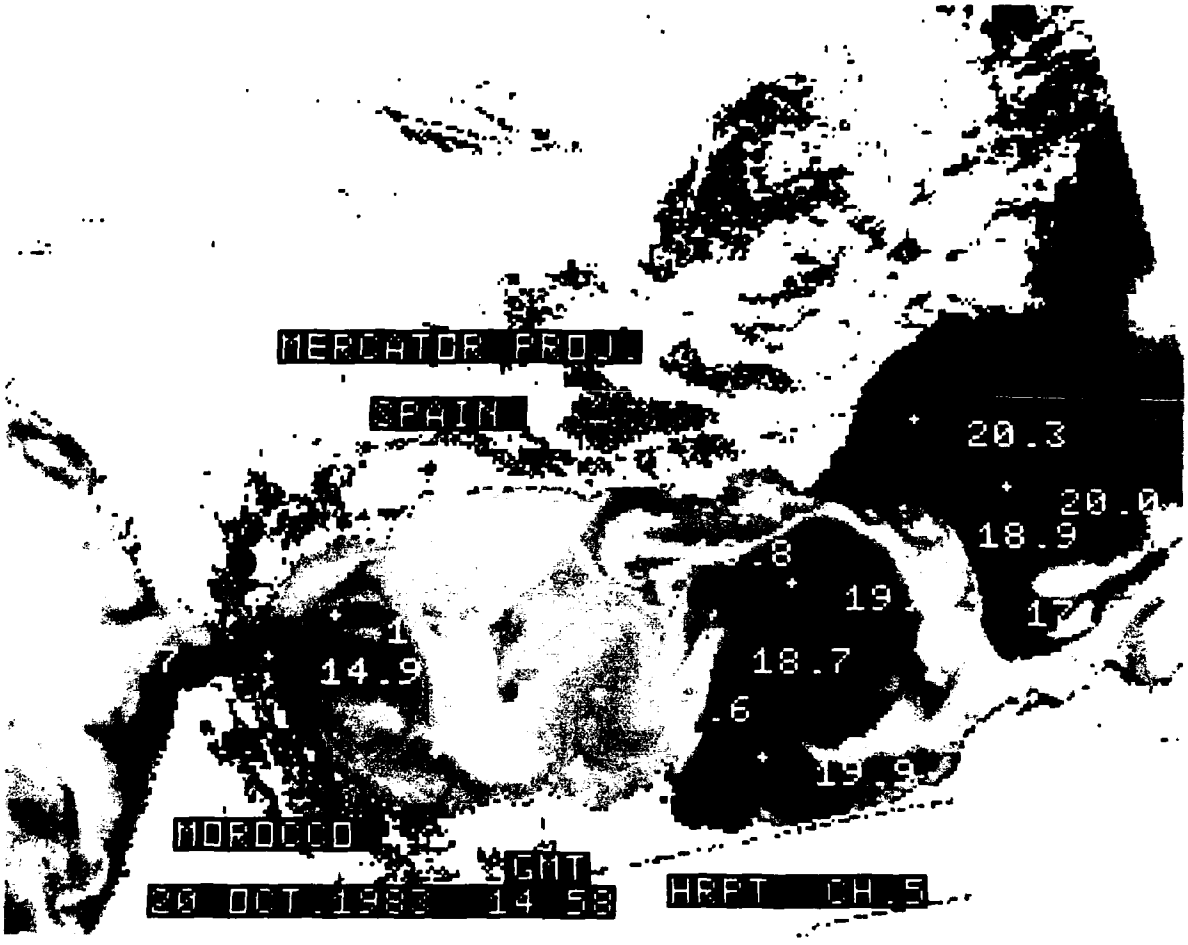
13i 20 October 1983
HRPT Channel 4, thermal infrared

Transformed to Mercator projection (north at top)

Methodology ---

Analysis *Thermal fronts are evident.*

PREVIOUS PAGE IS BLANK



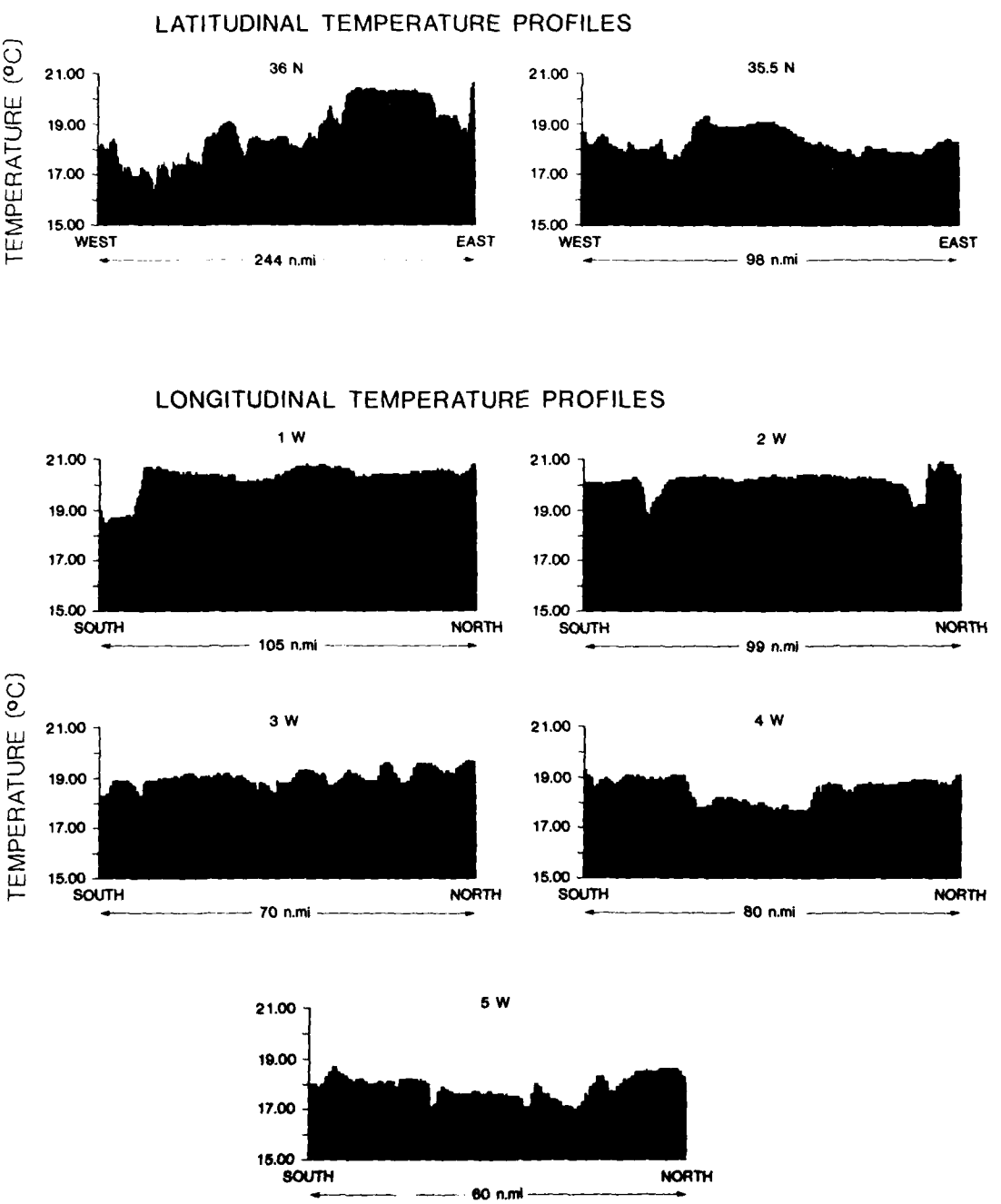
13j 20 October 1983
HRPT Channel 5, thermal infrared

Transformed to Mercator projection (north at top)

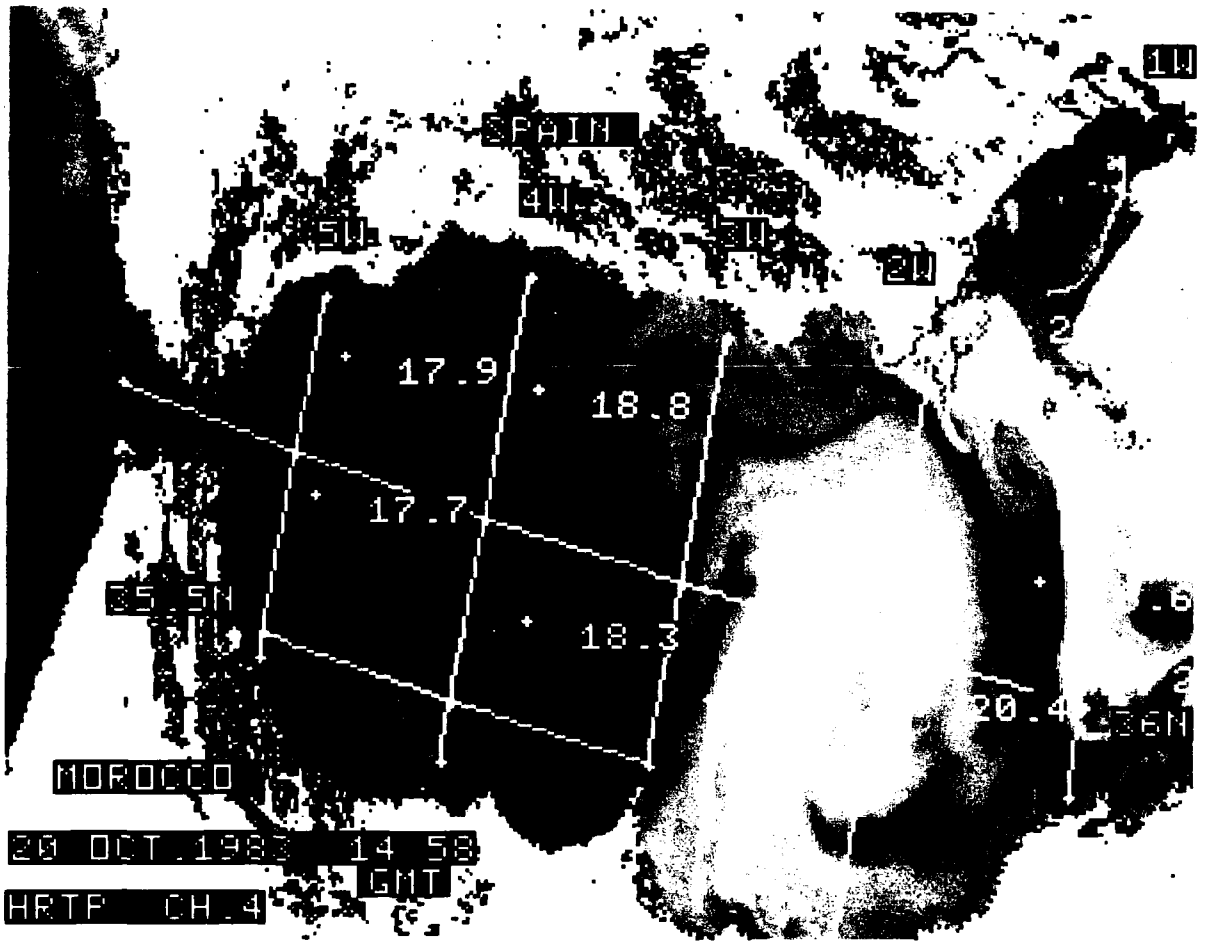
Methodology Some temperatures are shown for the different water masses; they are not corrected for atmospheric attenuation.

Analysis Thermal fronts are evident.

PREVIOUS PAGE IS BLANK



13k 20 October 1983
Temperature profiles along tracks shown in Fig. 13m
(not corrected for atmospheric attenuation)



13m 20 October 1983
HRPT Channel 4, thermal infrared

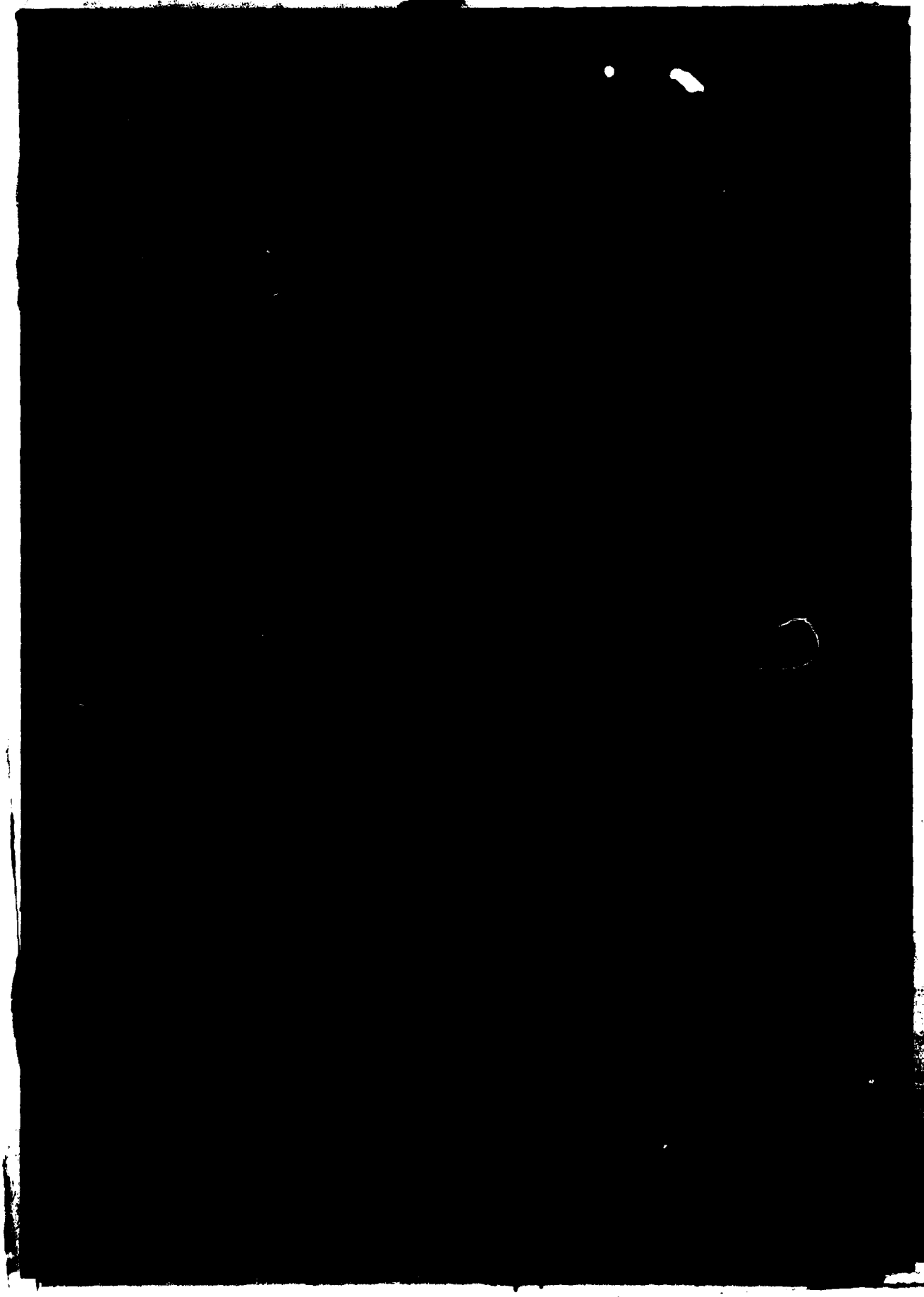
Original distorted image showing tracks of temperature profiles presented in Fig. 13k

Methodology Some temperatures of the different water masses are plotted; they are not corrected for atmospheric attenuation.

Analysis Thermal fronts are evident.

KEYWORDS

ACOUSTICS
ALBORAN SEA
APT
ATLANTIC WATER
AUTOMATIC PICTURE TRANSMISSION
CIRCULATION
GIBRALTAR
HIGH RESOLUTION PICTURE TRANSMISSION
INFRARED RADIATION
MEDITERRANEAN
MERCATOR
METEOROLOGY
MIXING ZONES
OCEANOGRAPHY
REMOTE SENSING
SATELLITE ANALYSIS AND RESEARCH SYSTEM
SEA SURFACE TEMPERATURE
STARS
THERMAL FRONT
TIDES
TIROS-N/NOAA7
TURBULENT HEAT FLUX
WATER MASS



END

DATE
FILMED

-86

DTIC